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READINGS FROM EXPERIENCE IN NAVAL ENGINEERING.

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A VERY important problem in the high-powered machinery of modern war vessels is the combination of economy at cruising speeds with power at the maximum speed. The size of the engine is necessarily fixed by the maximum power, yet this power in times of peace is used only on the rare occasions of full-power trials. Ordinary cruising takes place at about half the maximum speed, which corresponds to something less than one-eighth of the maximum power. If the machinery is designed for fair economy at maximum power, it will be enormously too large for the cruising power, and this leads to a marked reduction in economy.

Those who have not carefully investigated the subject are surprised to find that, while merchant steamers secure a horse power, with modern triple-expansion engines, for something less than two pounds of coal per i. h. p., it frequently happens that war vessels of the same size, at the same speed, use considerably more than two pounds of coal, and sometimes more than three. The cause of this difference is that in the merchant vessel the engine works under its best conditions all the time, while in the war vessel it is probably working under the least economical conditions. To obviate this, various methods have been proposed. One is that mentioned as obtaining on the New York and the Brooklyn, where there are two engines on each shaft, with a coupling between, so that at cruising speeds the forward engines can be disconnected and only the after ones used. Another is the use of triple screws, as on the Columbia and Minneapolis. Still another is the arrangement on the Nashville, where the engine works as a quadruple-expansion engine at full

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power, with arrangements for disconnecting the low-pressure cylinder and running the other three as a triple-expansion engine under ordinary cruising conditions. None of these is entirely satisfactory from all points of view, and each has some good features. As stated in the previous paper, the objection to any scheme which involves disconnecting part of the power on one shaft is that, in cruising under the economical conditions, should a sudden demand arise for full power, it may happen that time cannot be taken for making the connection. The triple screws avoid this tactical objection, and it seems probable that, as time goes on, their use will largely increase.

Another subject of great importance, with respect to economy, is that of the steam-consumption of the auxiliary machinery. In the early naval vessels of the United States navy there were very few independent auxiliaries, all the pumps for use during cruising being run from the main engine, which, of course, insured at least the economy due to that engine. But, as the rotational speeds have increased, it has been found desirable to require of the main engine only the work of driving the propeller, and this has led to the multiplication of auxiliaries, until some large naval vessels now have more than a hundred steam cylinders, besides those of the main engines. For simplicity and reliability most of these auxiliaries are driven by simple engines working without expansion and without jacketing, so that, as regards economy, they work under the most unfavorable conditions possible.

In a paper read last year by Passed Assistant Engineer White, of the United States navy, an account was given of experiments with the auxiliary machinery of the Minneapolis, which gave results that are undoubtedly true of any ship; in nearly every case the steam-consumption was very high, in some cases amounting to more than two hundred pounds of steam per i. h. p. per hour. Of course, in the case of these phenomenally high rates, the horse powers are extremely small; and it must also be remembered in this connection that, during ordinary cruising, only a small number of the auxiliaries are in use at the same time. But the fact remains that they are very wasteful, and that there is here a field for progress.

Numerous methods of increasing the economy have been proposed, some of which are thoroughly practical, and some, while very promising, are barred by the limitations of war-vessel design. All machinery on United States naval vessels is now arranged so that the exhaust from the auxiliaries may be turned into one of the receivers; where this has been done, a considerable saving in coal has resulted, amounting, in some of the larger ships, when running at a fair rate of speed, to several tons per day. An extension of this principle

has been proposed, where the cylinders of the auxiliaries would, in effect, form a part of the intermediate cylinder, as they would take steam from the first receiver and exhaust into the second. To this, however, there is the objection that, as war vessels are liable to be called upon at times to work with numerous stoppages, provision would have to be made, in addition, to take the steam direct from the boilers and exhaust into the condenser. Another scheme in use on the vessels now building is that of having the exhaust from the auxiliaries go through a feed-water heater, thereby saving a large amount of the heat which would otherwise be wasted when the steam is condensed in the main condenser. As it is very important that the feed water, before entering the boiler, should be as hot as possible, this method is advantageous from two points of view.

It has also been proposed to drive most of the auxiliaries (indeed, all of them) by electricity, and this has been done to some extent in the substitution of electric motors for steam engines or hydraulic motors for turning the turrets, and in the use of electric motors for hoists. Where the auxiliaries to be driven are far from the boilers, or where there would be great complication in pipe connection, the electric motors certainly offer points of advantage in facility of installation; unfortunately, there are disadvantages connected with their use, which count for a great deal where weight is so undesirable as it is on board ship. To be light, motors must run at a very high speed, and for most purposes on board ship this involves the introduction of gearing, which adds to the weight, and also is objectionable on the score of noise. Another very important feature is the fact that, thus far at least, the engines usually installed for driving the electric generators are not, in the long run, of very much greater economy than the small auxiliary steam engines which it is proposed to supersede by the electric motors; and, although the efficiency of both generators and motors is very high under the best conditions, these efficiencies fall off when worked at powers much below the normal. When the prime mover is itself not specially economical, the resulting economy may be even less than that achieved by the direct use of steam, while the weight in such a case is enormously greater. Before electricity can be used economically for driving the detached machinery, it is of first importance that the engine used to drive the generator not only shall be economical when new and subjected to test, but shall maintain the economy for a long time.

We have already observed that speed is a most important factor in all war vessels, and there is as yet no limit to this factor of the efficiency of the fighting ship. Not very long since, a speed of 16 knots was considered satisfactory for the heavily-armored battle-

ships, but contracts have just been placed for three vessels of this class in the United States, which are to have a top speed of 18 knots, and in the next ones to be laid down this speed will probably be at least 18½. There are a few battle-ships which exceed this figure, and the Italians are laying down three which are to have a speed of 21 knots, but these vessels will undoubtedly belong rather to the armored-cruiser class. Of the vessels in this latter class, several are now building which are to have a speed of 23 knots, the one nearest completion being the Jeanne d'Arc of the French navy, while the new Powerfuls about to be laid down for the British navy will combine with this high speed almost the offensive and defensive qualities of a battle-ship. The armored cruisers which the United States are likely to build, if congress grants the money at the approaching session, will probably not have quite so high a speed as this, as they will be some three thousand tons smaller. In the class of protected cruisers high speeds are also the rule, and the French expect soon to have two triple-screw flyers—the Guichen and the Châteaurenault—very much like the American triple-screw vessels, and of about the same size and speed.

A word may be said about the torpedo vessels, now divided into the destroyers and torpedo boats, although from the engineering standpoint they are practically identical except as to power. In these little vessels everything has been sacrificed to high speed, not only in the hull scantlings, but in those of the machinery itself, and wonderful results have been produced by the skilful utilization of the splendid material now available. In the war between the United States and Spain the torpedo vessels played a very minor part, and, indeed, may almost be said to have proved failures, as the American boats made no attacks and the Spanish boats were overwhelmingly defeated. I have never been a great believer in the important *rôle* assigned to the torpedo boat by many naval officers. There can be no doubt that, when efficiently officered and manned by trained crews, they may, in the hands of commanding officers of reckless bravery, do considerable damage; but it must be remembered that the vessels which they are to attack are likely to be manned by just as skilful crews under the direction of as good officers, and, if Wainwright in the little Gloucester could so easily demolish two destroyers (even admitting that they were inefficiently handled), what chance would such vessels have against the much more powerful secondary battery of one of the big ships? These little vessels are highly interesting from an engineering standpoint, and every one interested in naval warfare will await an opportunity for them to show what they are worth when properly handled.

A word also about the monitors. These too, in a large degree, are vessels in which engineers may take special interest, and I am a great believer in their efficacy when properly used. In the Spanish-American war their record is considered to have been a poor one, but this, in my judgment, was because they were diverted to uses for which they were never intended. They are purposely designed for operating near the coast, and have neither the speed or the coal-supply to enable them to make long cruises. This was the cause of the complaint that Sampson's movement against San Juan in Porto Rico was so greatly hampered by the monitors. It goes without saying that so able a commander as Admiral Sampson would never have taken the monitors on such a trip unless it had been absolutely necessary on account of the small number of battle-ships and the importance of utilizing the powerful guns of the monitors. At a recent meeting of one of the American technical societies a gallant captain of our navy, and a personal friend of the writer, who has had great experience with monitors from having commanded one for a considerable time, stated that, if given the command of the Monterey, he would be ready to fight any battle-ship afloat. I certainly do not advocate the building of monitors to the exclusion of vessels intended for the high seas, but as coast-defenders I believe they have no superiors.

It is very gratifying to be able to say that, in the main, the machinery of the United States vessels during the late war gave excellent satisfaction. This was due, of course, to the painstaking care bestowed by the officers in charge of the machinery, but it shows also that the machinery was well designed and of excellent material and workmanship. The famous trip of the Oregon is familiar to every patriotic American, and she made a record which will not easily be surpassed. After being under steam constantly for nearly three months, and covering a distance of about fifteen thousand miles, she was able to go at once on the blockade at Santiago, and in the fight of July 3 was the most important factor in the great victory. On that occasion she surpassed her trial performance in power, and almost equaled it in speed, in spite of a much greater displacement and a foul bottom. The ability to attain so wonderful a result after so long a period, without overhauling, is just cause of pride for all concerned in the design, building, and maintenance of this magnificent fighting machine.

One of the lessons of the war which is worth noting was developed from the use of a number of merchant vessels, armed with light guns and called "auxiliary cruisers,"—namely, that there is a material difference in construction between the machinery of naval vessels and that of the merchant marine, and that the engines of merchant vessels are not entirely adapted to the conditions of naval service without im-

portant additions. This is only natural on account of the difference in the duties of the two classes of vessels. The merchant steamer makes her trips under absolutely uniform conditions, while the naval vessel must be ready for constant manœuvring. As already remarked, the modern naval engine does nothing but drive the propeller, the working of the pumps and other auxiliaries being left to auxiliary engines. This is not the case with the merchant engine, and it was soon found that vessels of this class required additional pumps to keep their condensers clear of water while the vessels were lying under steam, ready for use at short notice. It was found also that very few of the merchant vessels were fitted with evaporators, having always run between ports where fresh water of excellent quality could be obtained in large quantities, and possessing the capacity for extra boiler-feed in the double bottoms.

Before war was actually declared, and as soon as it became imminent, a plan long formed was carried out,—that of equipping a vessel as a floating machine shop; this gave us the vessel known as the Vulcan. Plans for such a vessel had been prepared some years ago, when war between the United States and Chili seemed imminent, so that it was necessary only to modify the original plans to suit the ship that was purchased. It was almost certain, *a priori*, that such a vessel would be of the greatest service to the fleet, and actual experience with the Vulcan has confirmed all expectations. Every officer in the American fleet at Santiago, from the admiral down, has praised the usefulness of this vessel. Space will not permit the giving of a complete list of her tools, but it may be said that her equipment was equal to that of any but large repair-plants on shore, and the work actually done by her covered almost every conceivable part of the machinery of a war vessel, including repairs to hulls, gun mounts, dynamos, main steam pipes, main piston rods (for small ships), brass castings without number, and a considerable quantity of iron castings. This last is an especially interesting feature, as it is believed that the Vulcan is the first vessel ever fitted with a cupola for making iron castings. The object of such a ship is readily seen; it enables the vessels to have every repair, short of a breakdown of some of the larger parts, made on the station, when otherwise they would have been compelled to go at least several hundred miles, and in some cases more than a thousand, to reach a repair-yard. The Vulcan also carried an enormous supply of engineering stores, which proved of the greatest value. Provision had been made in other navies for vessels similar to the Vulcan, but this is the first case in which one was used in actual warfare.

It became evident at an early stage of the blockade that the prob-

lem of supplying an adequate amount of fresh water for the boilers was an important one. With the high pressures now carried it is absolutely necessary that only fresh water should be used in the boilers, and the ordinary evaporating plant, because of limitations in space, is sufficient only for ordinary cruising with a portion of the boilers. Key West has no natural water-supply, except rain, and the reservoirs were soon emptied. A multiple-effect distilling plant was installed there to remedy the natural deficiency. Before this, however, arrangements had been made to equip vessels as distilling ships, and two of them have been fitted out—the Iris and the Rainbow. Each of these has a triple-effect distilling apparatus with an average capacity of about 60,000 gallons per day. The Iris showed, on a test, with clean heating-surface, a capacity of more than 70,000 gallons of potable water and more than 100,000 gallons of water fit for boiler use. These vessels are fitted with a tank-capacity of about 1,000 tons, and carry a coal-supply of about 3,000 tons. They are thus particularly valuable adjuncts to a modern fleet, being at once a source of supply of both coal and water, the latter normally and the former in an emergency where coal would be more important than water. Unfortunately neither of these vessels was completed until the naval part of the war was over, and, on account of the lack of fresh water, there was trouble on several ships with collapsed furnaces, due to the formation of scale in consequence of the forced use of salt water for extra feed. It seems very probable that vessels of this class will, like the repair ships, be a necessary addition to a modern fleet operating away from a base where fresh water can be obtained in large quantities.

The experience of the war enforced the importance of another fact, which would be very obvious on consideration,—namely, that there should be adequate provision for a trained engineer force on which the navy may draw in time of war. A great deal has been done in the United States towards the organization and training of a naval militia as an auxiliary to the navy, and the men of this organization rendered valuable service during the war; but, except to an extent so slight as to be almost negligible, no effort had been made to supply trained men for the work of the engineers' force. As a result, a very large proportion of the men who volunteered were absolutely green, and many of them had had no experience whatever with any kind of marine machinery, having never been either to sea or on board a ship of any kind. One of the younger officers of the engineer corps, who was the chief engineer of the Merrimac, wrote some exceedingly amusing letters about his experience on that vessel when she was first commissioned, the fact developing that, out of his whole crew, only one man had ever before been on a ship. He likened their astonish-

ment, when the engines were first turned over after considerable difficulty, to the open-mouthed wonder with which a crowd at a country fair views a balloon ascension. So far from casting ridicule upon the brave and self-sacrificing men who, absolutely strangers to the conditions of naval life, volunteered for it, I cite this case only to show the mistake which has been made in not providing adequately for a trained engineer division of the naval reserves. The need is obvious enough of such an organization among the engineers, mechanics, and firemen of our merchant service, who are accustomed to marine machinery and have the sea habit, as will enable the government, on occasion, to man the engine and fire-rooms with these men, who will need only a short training to make them feel at home and render highly-efficient service.

One lesson which this war has thoroughly taught is the vital importance, to a nation which would have an efficient navy, of the fostering of the mechanical instinct. Americans may be proud of being a nation of mechanics, and I attribute the overwhelming victories over the Spaniards largely to this fact and the absolute lack of any mechanical aptitude on the part of the opponents. It is a notorious fact, to those whose travels about the world have brought them in contact with Spaniards, or people of Spanish descent, that this race has never developed mechanical engineers of decent ability, and that the mechanic, in fact, is scorned, instead of being honored and respected. The utter failure of Cervera's fast armored cruisers, which had trial speeds of 20 knots, to escape from the United States vessels at Santiago, none of which were making 17, shows the disastrous results of discouragement of the mechanic. As we now know, the condition of the two fastest ships at Santiago, the New York and Brooklyn, was such that only half power could be used immediately, and it seems almost certain that, had Cervera's ships been able to make their maximum speeds, they would have escaped. The mechanical instinct, too, is just as important for the care and manipulation of the modern guns and turrets as for the care and manipulation of the motive power, and I believe that in this respect also the mechanical aptitude of the American people was an important factor in the victory.

The object of a naval vessel is to perform her full duty in the hour of battle, and, unless the performance in this crucial time is satisfactory, the vessel must be considered a failure, however admirable from other points of view. The war which has just ended was so one-sided that many are inclined to think that, from some points of view, many questions still remain unsettled. So far as the machinery is concerned, however, the test seems to have been thorough, warranting the conclusion that the work hitherto has been on correct lines, and

that the work done by the machinery during the war was excellent. So far as can be now seen, there does not seem any probability of immediate changes so radical as the sudden jump in pressures from the compound to the triple-expansion engine, the great increase in rotational speeds, and the abandonment of the cylindrical boiler for the water-tube boiler, which have already taken place. The remarkable performance of the Turbinia in 1897 aroused great interest, and some of the more sanguine look to the steam turbine as the next great improvement in marine engineering. So little is known of the details of the Turbinia, and the data that have been published are of such a nature, that it seems improbable that the steam engine will be displaced by the steam turbine very soon, if at all. The demand will continue for higher speeds, and this means further reduction of weight per unit of power. There will also be a steady effort for an increase of economy. These desiderata will give designers scope for the exercise of their talents.

It is evident that the United States navy is destined to a great expansion, and this will demand for its highest efficiency a highly-trained personnel. The naval personnel bill, recently before the United States congress, will make all the officers concerned with the management of the men and the direction of the vessel and her motive power engineers as well as deck officers. This I believe to be only the first step towards the organization of the navy in accordance with the conditions now obtaining, and the next step will be the making of every enlisted man a mechanic as well as a seaman. This is exactly similar to the change which occurred many years ago, when the sea-soldier and the sailor, both officers and men, became amalgamated; and it will give us not only the fighting engineer as our naval officer, but the fighting mechanic for our man-of-war's man.

AMERICA AND GERMANY AS EXPORT COMPETITORS AND CUSTOMERS.

By Louis J. Magee.

II.—ECONOMIC LEGISLATION, AND ITS INFLUENCE ON INDUSTRY.

ENGINEERS should not refrain from expressing their opinions on this subject simply because they are not professional economists; for, if, on the one hand, the economists are free from partiality for any one branch of trade or industry, it is equally true that they are not conversant with the practical considerations which underlie statistics.

The conservative—agrarian—element in Germany is in opposition to the liberal element in that it demands a tariff highly protective, especially of food stuffs, opposes commercial and tariff treaties, and, in general, fails to realize that the fostering of German export industry is a fundamental condition of the nation's prosperity. The emperor sees that the agrarians about him are on the wrong track. He meant a great deal when he said: "Our future lies on the seas."

Considering the three great groups into which the income of the German custom house is divided, the value of the duties received in each group, with reference to the estimated value of the articles imported, shows for 1897 a duty of 1.3 per cent. for raw materials used by the industries, 11 per cent. for manufactured goods, and 21.1 per cent. for food stuffs. The total amount of duties collected in that year, 475,000,000 marks, is 10.1 per cent. of the value of the imports. If we now exclude all articles which are free of duty, we find that the duties collected amounted to 18 per cent. of the value of the dutiable imports. Considering only the dutiable articles in the three groups above mentioned, raw materials are found to have paid a duty of 7.02 per cent., manufactured goods 16.05 per cent., and food stuffs 22.74 per cent.*

From these figures, which agree fairly well with the average of the last few years, it is evident that the agricultural interests of Germany are protected in a higher degree than are the manufacturing interests, and that the industry has the advantage of practically a free introduction of its raw materials.

Per capita of the population the duty paid for grain in 1897 was 2.51 marks; for petroleum, etc., 1.18 marks; for coffee, 1.01 marks; for wine, .28 marks; for iron wares, .091 marks; for machinery, leather, wooden wares, eggs, tea, horses, and cattle, about .046 marks.

* *Statistisches Jahrbuch für das Deutsche Reich*, 1898.

Now, the manufacturers, differing in their ideas as to the extent of tariff protection, according to the influence of foreign competition on their respective branches, seem to agree in general upon the desirability of stable trade relations with foreign countries guaranteed by commercial treaties. The present tariff is being revised, and, although a new one cannot come into force until the existing commercial treaties expire (1904), the revision will be used as a basis in negotiating new treaties before that time. The present tariff is too general; it needs to be specialized according to modern requirements. Without giving up the principle of a tariff based on weight, and without going so far in specialization as to lose the advantages of a classification which leaves room for every conceivable article, a great deal may be done to make the present form of the tariff more equitable and rational.

At present, bicycles and rifles fall under the general position of fine iron ware, but the value of these articles is much higher in proportion to their weight than the framers of the tariff thought it likely to be. The result is that bicycles pay only about 1.9 per cent. duty, and rifles 4.5 per cent., while rough iron castings pay 21.7 per cent., tin-plate about 20 per cent., iron and steel wire 10.3 per cent., tools 10 per cent., and machinery in general 2.5 per cent. to 7.1 per cent. —sewing machines, for instance, paying only about 2.5 per cent. While equality was not intended, such discrepancies as these are clearly unreasonable.*

The ministry of the interior formed a commission of thirty members from the agricultural element, trades, and industries, to advise the government on the revision of the tariff and the preparation of future commercial treaties. The majority of this commission is for protection. Independently of this commission, important representatives of commerce and industry have created a central office to receive and work out all suggestions and statistics with a view to safeguarding their interests as opposed to those of the agrarians.

Just as the United States have enjoyed the advantages of internal free trade among States whose laws and customs, needs and resources, vary most widely, so in the last quarter of this century Germany has had the advantage of free trade among the widely-varying peoples within its imperial borders. Great Britain, lacking an internal empire, had long ago to adopt the principle that political boundaries have nothing to do with commerce, seeking its markets abroad and buying of all the world. Now that Germany and the United States have gotten beyond the point where internal free-trade furnishes enough purchasers for the products of highly-developed industries, they, too, must sooner or later follow England's example. Germany

* *Stahl und Eisen*, November 22, 1898.

has developed as an industrial nation without a highly protective tariff; one industry after another has grown up without protection, urged on by the promising prospects of a market supplied for the time being from abroad. With modern facilities for transportation there is no reason why every political division of the earth need foster the production of every necessary article on its own soil. If the Swiss have made a specialty of cheap and good watches, there is no reason why the people of Germany should not be as free to purchase them as watches made, say in Baden, nearly as far away from the centre of Germany as Switzerland,—in fact, just within the imperial border. The Germans are manufacturing excellent watches, but it is certainly to the advantage of the people that they are not obliged to go without watches or take what the German factories can give them for their money, just for the sake of inviting the participation of a few million marks more of capital in the watch industry and an eventual overproduction.

As opposed to the oft-quoted instance of the sudden development of the tin-plate industry under high tariff protection in the United States, it is interesting to note a case where a tariff left low intentionally had the effect of developing an enormous industry in Germany. At the time of the framing of the present German tariff, in 1879, the manufacture of machines for the textile industry, or of any machine for that matter, was not very highly developed. German spinners and weavers were obliged to get their machines from England, as they do largely to-day. Thus having the advantage of English experience, and being free to import English machines, the Germans have developed a textile industry which exported goods to the value of about 776,000,000 marks in 1897, or about 20 per cent. of the total exports. In the making and selling of this branch of manufactured products vastly more hands are occupied and more capital invested than there would be, had the importation of those early machines been rendered difficult by high duties. To-day the textile industry is purchasing a part of its machinery from England, a part from Switzerland, and some types exclusively from Germany, according to the specialties developed. This state of affairs was brought about perhaps by the accident of invention; perhaps by the peculiarity of the raw materials used in each case, the local methods of working, or the characteristics of the laborers,—*naturally*, in any case, and not *artificially*, by a high tariff.

In addition to the customs, the German government has a revenue of about three-fourths as much more from the taxes on beer, distilled liquors, tobacco, salt, and sugar. Stamps on bills of exchange, contracts, bills of sale, playing-cards, and lottery tickets produced a

revenue of 60,842,000 marks in 1897, one-third of this sum coming from lotteries alone. Contracts closed in Prussia must be provided with a stamp of a value of from one-tenth to one-third of one per cent. of the materials to be delivered or the values involved, exclusive of labor. Government auditors make frequent visits at short notice, and look through the contracts, so that great precision and caution are customary. This seems a source of income which has least of all the appearance of oppression, as a stamp revenue is indicative of a corresponding profit for those who pay it.

The German laws for stock companies protect the public investor very strictly. Printed annual reports of managers, approved by the boards of directors, are compulsory, and free to the public. Stock companies are not registered without previous careful examination, and, in cases where patents or manufacturing experience are given in return for a certain number of shares, it is expected that the latter shall form only a comparatively small part of the capital. In general, I think that German financiers consider American methods less secure than their own, because of the lack of unity in the corporation laws in various States of the republic, and because stock companies are sometimes not sufficiently protected from the danger of improper management by limitations on the power of the individual.

Contrary to the practice in America or England, manufacturing establishments of all kinds, inventions, street railways, and lighting and power plants are financed and founded, or bought up and reorganized, by banks and banking groups. In England the public responds directly to the invitation of the promoter or inventor. In Germany the bank must sign its name first, to inspire confidence. The bankers and great *chefs d'industrie* are conservative, yet courageous; economical, yet liberal. They insist upon rating assets at the bed-rock value. They prefer to write off more for depreciation than the laws dictate; they oppose measures which could weaken the credit of their companies. Not forgetting, of course, their own profit, they risk their financial reputations at this business of promoting industries. Out of 294 industrial companies selected from those whose shares are quoted on the Exchange of Berlin, 94 companies paid in 1897 dividends of from 6 to 9 per cent., 84 paid dividends of 10 to 14 per cent., 35 gave 15 to 19 per cent., 12 gave 20 to 25 per cent., and 7 companies paid a still greater dividend. Only 21 per cent. of all the companies paid less than 6 per cent.

The great industrial boom, with its attendant craze for the formation of new companies, is expected by many conservative Germans to be followed by a great falling-off in business, due to over-production, etc. But no signs of such retrogression are at present noticeable.

One cannot help feeling that the present prosperity rests on a good foundation under the German system,—a system where managing directors are so often hauled over the coals by intelligent supervisory boards, where assets are so closely examined, and where the possibilities of future losses are so conscientiously discounted by reserves equally fair to the present and morally due to the future stockholder.

The insurance department of every great industrial house plays an expensive, complex, and interesting *rôle*. First of all comes the Imperial Fund, for age and invalidity (established in 1889), to which all employees earning less than $500 per year have to contribute, the employers paying an equal percentage. This fund provides for a pension due after the seventieth year, or in case of invalidity not due to accident. In 1897, 452,300 pensions were paid.

Second comes the accident insurance, for all employees earning below $1,250. This system, called the "Berufs-Genossenschaften," or Employers' Liability Associations, is semi-official, and is supported entirely by employers, who are obliged to pay a certain percentage on the amount of their wage-list, varying with the number of accidents. There are sixty-four of these associations for industrial, mining, and marine, and forty-eight for agricultural, pursuits. To them are to be added the State employees on the railroads, postal department, etc. These associations pay pensions to widows up to 60 per cent. of the wages of those who meet death by accident, and pay all other costs resulting rom accidents, as far as such are adjudged by the courts. In 1896 these institutions had to deal with 7,101 cases of death and 86,403 cases of injury, distributed among about 17,000,000 persons.

Furthermore, for those employees who receive a salary of more than $1,250 per year it is customary for the firms to take out a collective insurance against accidents happening in the course of their occupation. This is arranged by the firms with private insurance companies, as is also a further general liability insurance covering the firm for all liabilities arising from accidents to employees or outside parties,—for instance, people who are run over by electric cars.

There is still another institution, called the "Kranken-Casse," or Sick Fund, established in every town and city. Any firm employing more than fifty hands may establish one for itself, under government control. All employees receiving less than $500 per year contribute to this fund, which serves for medicine, surgical attendance, hospital expenses, etc., up to the extent of one year's illness. The contribution amounts to about 2¼ per cent. of the average wages, and one-third of this is paid by the employer, two-thirds being paid by the employee. About eight millions of persons are enrolled in this department of insurance.

The present session of the German reichstag will take action on a question which has a most important bearing on the freedom of the laborer. The emperor referred in strong terms to the preparation of some such legislative act, in a Westphalian speech in the summer of 1898; and he touched upon the matter again in his address on the occasion of the opening of the reichstag in December, 1898, as follows:

> The terrorism by which those who are willing to work are hindered from the continuation of their work or from accepting new work has assumed dimensions harmful to the common weal.
>
> The right of coalition (for strikes) granted to laborers will not be in the least altered or weakened, but this right must not be misused by threats and intimidations to crush down that higher right,—namely, to work and live from work.
>
> It is, according to my conviction and that of the leaders of these Confederate States, the absolute duty of the State to protect personal freedom and free will; but the law and punishments at present existing to cover such cases are not sufficient; they need to be extended and completed; and I trust that you will not fail to signify your agreement with the law which has been drafted for the protection of the workmen in this respect.

During the last few years a large number of cases have come up in which it was impossible, according to law, to mete out justly-deserved punishment to those doing violence in times of strikes. The new law is supposed to contemplate extremely severe dealing with the instigators of strikes and all persons who come between the employer and the laborer. These sharp measures are likely to call forth great opposition from the Socialist party.

German patents are especially valuable, because the search for previous publication is, comparatively speaking, thorough. The government takes no responsibility, however, for the correctness of its examination. The claims are also reduced to a minimum of conciseness. The public are invited to produce evidences of priority, or otherwise attack the claims of the inventors. To this end the papers are publicly exposed for six weeks after the patent office has finished its examination and before the patent is definitely granted. Much patent litigation is probably thereby avoided, and the public is less likely to be led into investments based on patents lacking in novelty and unable to withstand the attacks which commercial success is sure to call down upon them. If a patent can exist five years without being attacked, it is sure of the rest of its term. A high technical authority* criticises the German patent office as lacking in experts with practical knowledge, one-sided in its views, careless in its examination, and lacking in uniformity as to the fundamental principles of patent practice in its various departments. Despite the importance of this critic, a com-

* Prof. Riedler: *Zeitschrift des V. deutscher Ing.*, No. 48. 1898.

parison, were it possible, would probably show that the German patent office has kept pace with industry as well as could be expected. He is certainly justified, however, in calling attention to insufficient examination for novelty. Americans have frequently entered into negotiations for the sale of inventions which they believed to be as well protected by the German as by the United States patents, only to learn ultimately that some unimportant detail alone had been covered in the claim. Inventors should personally assist their agents in answering the objections of the patent office and explaining points which the examiners fail to understand. German patents have an important influence on the decisions of other European offices, while Belgian and French patents are allowed without examination as to novelty.

As to the bad feeling which has recently existed between Germany and America, Ambassador White, speaking from a long experience with Germany, where the respect for him is not confined to official circles, said publicly: "I believe that the feelings of the great majority of the thinking German people are friendly toward us, and this great majority have the wit or the instinct to discern the real reasons for any injustice that may be done our country by individuals, ... and I declare my full faith that, whatever prejudices may affect any of the German people for a time, we may confidently count upon the final supremacy among them of right reason and justice."

Along with the high appreciation of the accomplishments of Americans as a nation, there is probably a well-restrained dislike of Americans in some circles in Germany. Certain branches of industry can hardly help some feeling against their republican competitors. The recent importations of American iron and machinery are certainly not calculated to smooth the feelings of certain classes of manufacturers. They feel embittered that they have not a better chance of selling to America, and forget very naturally how their colleagues in other branches of industry live on American trade. All the machinery sold in 1897 to Germany by the United States, including the much-berated bicycles, does not equal in value, for instance, the one item of German gloves imported into the United States. Instead, however, of allowing ill-feeling to continue, let us rather wonder that Germany has not already put up more barriers against the United States; let Americans show their love of fair play in the international market, and not restrain the admiration they must certainly feel for a nation which, without natural advantages such as theirs, can work up an export balance of manufactures amounting to $318,710,000 while keeping an army of 585,000 men up to the highest point of physical and scientific training.

RAILWAY LOCATION AND SURVEYS IN RAJPUTANA, INDIA.

By C. H. Croudace.

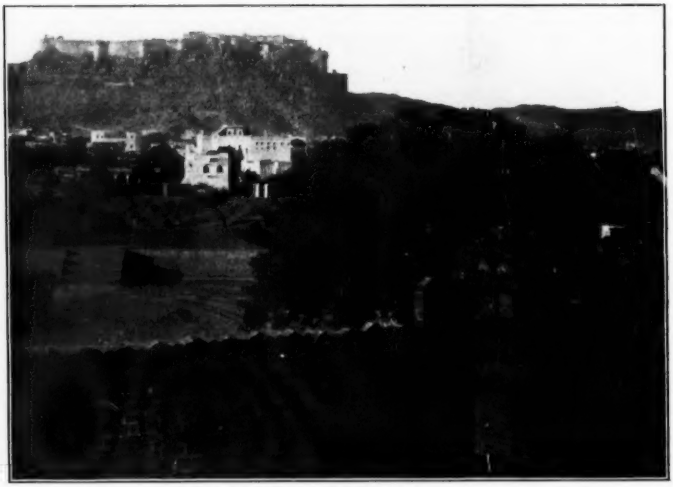
IN a paper entitled "Some Features of Indian Railways," in the July number of THE ENGINEERING MAGAZINE, allusion was made to the prompt and economical manner in which railway surveys are carried out by the government of India. The Delhi-Kotri project of 1889–90 is an example of a long line of survey carried through expeditiously, and, now that such surveys have to be undertaken on a large scale in China and elsewhere, an account of it should prove interesting to engineers and promoters.

The idea of connecting Karachi to Delhi by a direct line (in lieu of the circuitous Indus valley route) originated with Sir Bradford Leslie and others in 1887. They saw the importance of such a route, now increased by the old and also recent agitation for making Delhi the official capital of India and thus avoiding the annual exodus from Calcutta to Simla and back A reconnaissance of the route was forced on the government of India by the merchants of Karachi in the cold season of 1888–89, and reported on unfavourably by Mr. H. Bell. Nothing daunted, the Karachi merchants, led by the late Mr. McHinch, agitated for a detailed survey, offering to bear the expense. The government, however, decided to make the survey, which was entrusted to the writer. Special study was to be given to the great sand ridges in Sind, which were supposed to mar any practical project for a distance of one hundred miles, or about a fifth of the length to be surveyed.

Prior to the reconnaissance little or nothing was known of this desert in an engineering sense, as the once-well-traversed trade route of 130 miles, running south-west from Jeysilmir, the capital of this desert State, to Umerkot, was gradually abandoned with the completion of the Indus Valley Railway from Kotri to Sukkur. The student of Indian history will remember that the emperor Humayon, the great Akber's father, was a fugitive through this desert, losing many of his followers from thirst, and that his son was born at Umerkot. A tablet erected to his memory by an English official marks the site of this event. Again, some of the chroniclers mention that heavy brass cannon were dragged with great difficulty over the sand ridges from Umerkot to the hill fortress of Jodhpur, some two hundred miles eastward. Even the ubiquitous survey department of India had not mapped out

the country stretching from the sandhill-girdled fort of Umerkot on the west to the yellow-limestone-built city of Jeysilmir on the east, a length of one hundred miles. The nature and lie of the sand ridges were, therefore, unknown until reconnoitred by the writer in 1889.

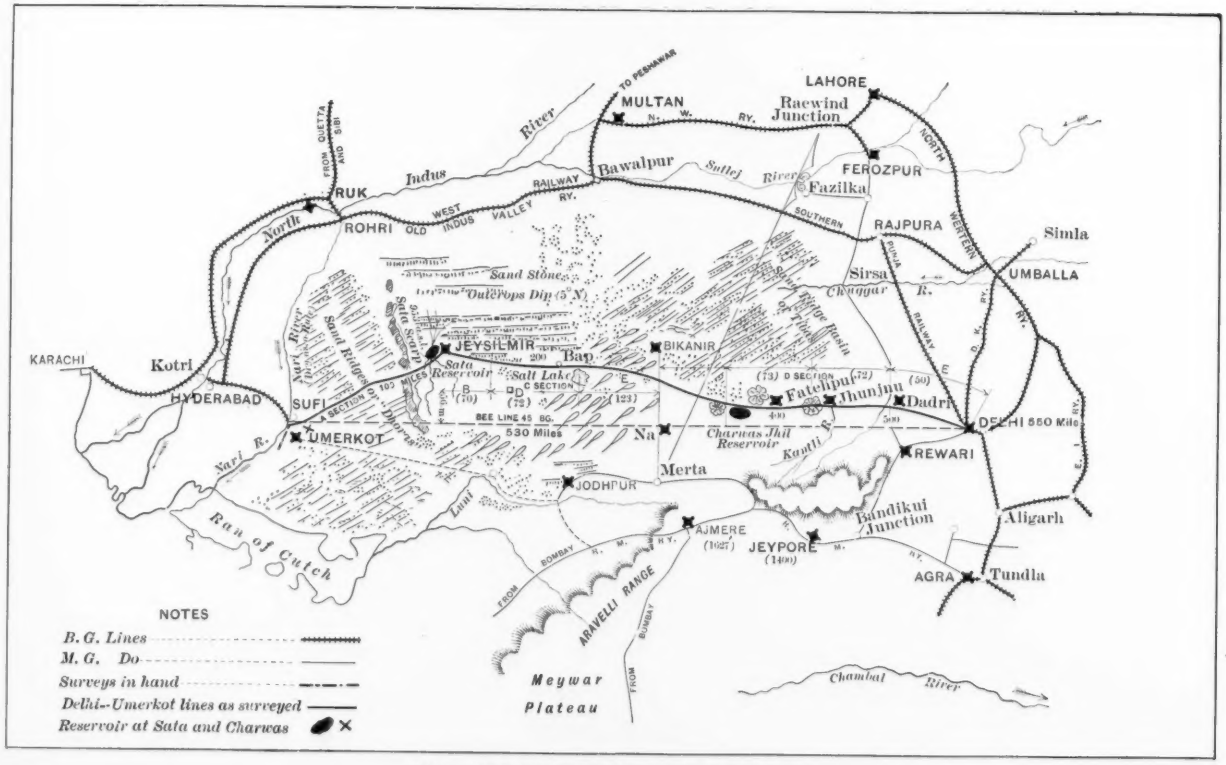
To realize the location, draw a bee line on the map from Sufi on the Nara river (twelve miles west of Umerkot) to Delhi, a length of five hundred and thirty miles, with a bearing of 42°, or nearly due north-east. The route surveyed forms two sides of a very obtuse triangle on this base with its apex at Jeysilmir—*vide* map. The alignment is five hundred and fifty miles long, or only 3.8 per cent. in ex-



THE FORT, JODHPUR.

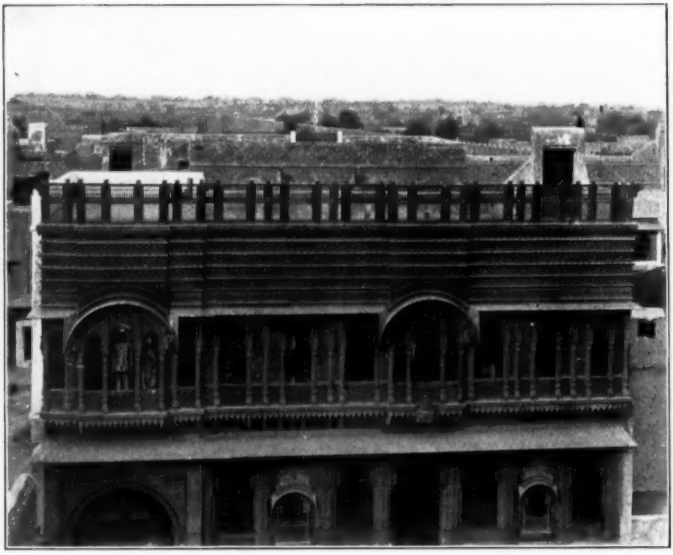
cess of the bee line,—probably the shortest alignment over a long railway in India. Starting from the west end, the line passes through Sind in a north-east direction for 50 miles; then through the native Rajput States of Jeysilmir, Bikanir, and Jeypore for 415 miles; and, finally, through 85 miles of British territory to Delhi, the terminus. The compass bearings are: north-east for 140 miles, and then east-north-east for 410 miles, to Delhi.

On the first 140 miles there are but two large stone and mud-built villages, each having a well 300 feet deep and containing brackish water. The other places passed are mere herdsmen's hamlets, built of conical-shaped wattle and dab huts, with rude folds for camels and cattle. From Jeysilmir (136th mile) to the picturesque and well-



MAP OF THE DELHI-KARACHI DIRECT RAILWAY.

built town of Futehpur the distance is 213 miles,—a long stretch of rocky or sandy country, with villages ten to fifteen miles apart. This town has a famous "Bowli," or underground, arched-in reservoir, some one hundred and twenty feet deep, approached by a long flight of steps leading to arcaded stages,—the largest structure of its kind in



VIEW OF BIKANIR FROM THE ROOF OF A MERCHANT'S MANSION.
City walls in middle distance. The stone carving on the house is modern.

India. The intervening villages depend for their water supply on wells averaging 400 feet in depth, worked often by four inclines with 16 pairs of bullocks, which haul the "citurus," or leather water-bag, up the inclines. When the bag has traversed two hundred feet, being then half-way up, a second pair of bullocks, in readiness at the top of the incline, pick up the rope for another run of 200 feet to the surface. The stone cisterns built around each well are a leading feature in village life, as the numerous herds of cattle, sheep, and camels have to be watered morning and evening.

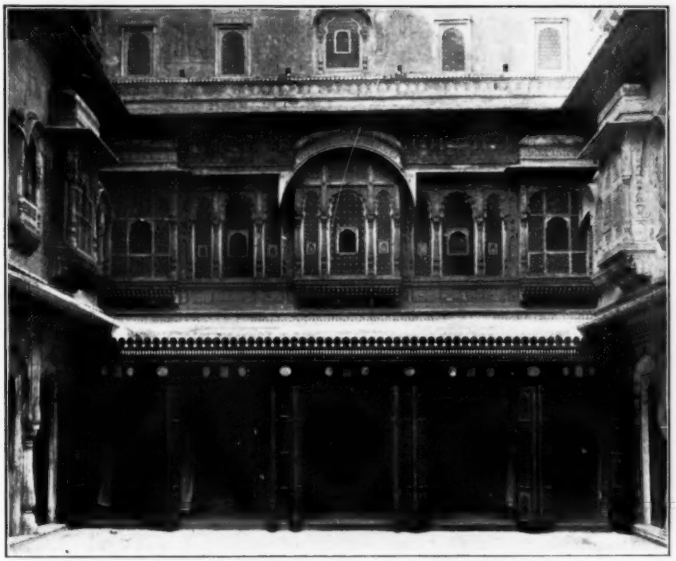
East of Futehpur the distance to Delhi is 150 miles, and some highly-interesting towns are passed. These towns are the retreats of the well-known trading class called the "Marwaris," who build their mansions, or "havelis," in these sandhill-locked oases, and retire to them to pass their declining years. Here in ante-railway days

they were safe from unscrupulous rajahs or daring decoits bent on getting their hoarded treasures.

To avoid a long description of this project, this paper will deal only with two leading features,—the sand-ridge and desert country, one hundred miles in width, and the water-supply, carried out by means of high-level reservoirs and a pipe line three hundred miles in length.

The route surveyed may conveniently be divided into five sections (A to E), varying greatly in character, of which the most westerly is the most unique and interesting.

(A) *The "Dhora" country, or west section of 120 miles* (rising from 37 to 953 feet above sea-level). This length includes twenty miles of the irrigated plains of Sind, followed by one hundred miles of parallel sand ridges and narrow vallies, which rise abruptly two

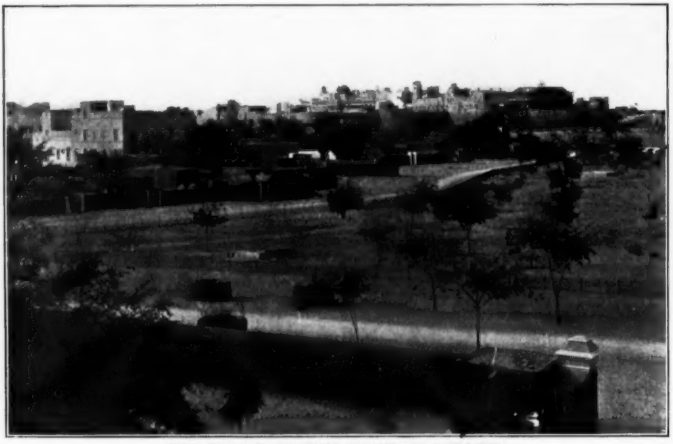


VERY OLD STONE CARVING IN THE PALACE, BIKANIR.

hundred feet from the plains, and reach one thousand feet at the east end. They may be described as the "fingers and knuckles" formation of sand ridges, locally called "Dhoras." These ridges are strictly parallel to each other, and vary from thirty to one hundred and twenty feet in height, being separated by intervals averaging one-third of a mile.

A 300-FT. WELL—THE DEEPEST IN BIKANIR. CITY WALLS IN THE BACKGROUND.

They spring from low cross ridges, or saddles, like closed fingers from the knuckles of the back of the hand, but in reverse and parallel directions. That is to say, the ridges face both north-east and south-west, covering a longitudinal distance of one to two miles, when they are again repeated in a similar formation. Their cross slopes average 2 to 1, and are well covered with desert grasses and bushes, an occasional acacia or rohira tree breaking the monotony of the landscape. They rest on a base of indurated soil called "pan," in which are occasional large areas of gravel and *débris* of dark



THE PALACE OF THE RAJAH OF BIKANIR.

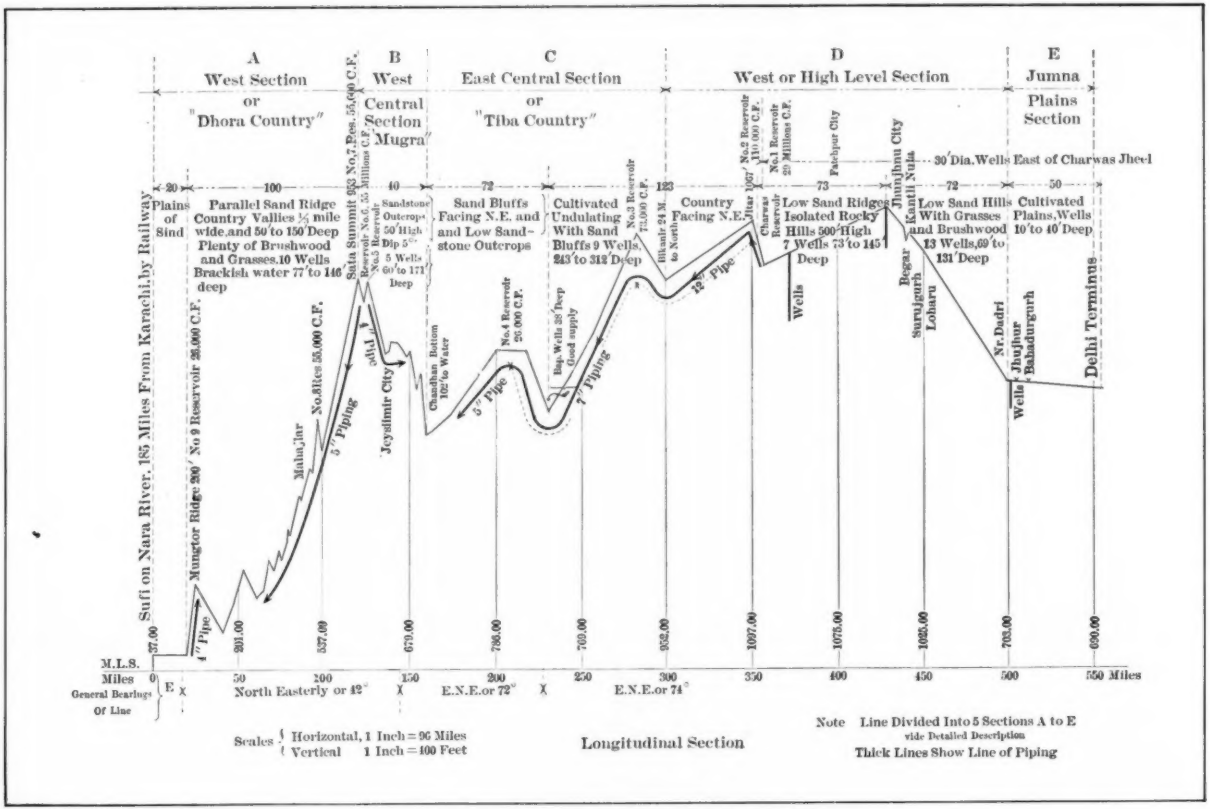
brown, glistening, granular rock. This peculiar formation ends abruptly at the sandstone cliffs of Sata, about one thousand feet above sea-level, which form a barrier to their further extension eastwards. When seen for the first time from these heights, they have a confused wave-like appearance, and it is only ultimately discovered that they form in plan parallel, but tapering, ridges.

With the exception of the field rat, animal life is absent, and the old trade route is mostly indicated by the skeletons of camels, which dot the track at short intervals. The monotony is relieved by occasional bluffs, or mounds, from the top of which only similar trough-

ON THE MUSHKAF-BOLAN RAILWAY.

like vallies are observed. No nala, or even serviceable tank, is found, although the scoring of the surface indicates that there must be occasional heavy downpours. But, with all this, the country is the grazing-ground of numerous herds of camels, cattle, and sheep.

(B) *The "Mugra" country, or west central division of 40 miles in length* (falling from 953 feet to 500 feet below sea-level). Here we enter into a different country altogether: a land of sheet rock covered with cactus bushes and rejoicing in one large, picturesque old town. It separates the western (*a*) and east central (*c*) countries by a tongue-shaped area, called locally the "Mugra," with its cliffs, or outcrops, fifty feet high, of alternating strata of reddish sandstones and dull yellow limestone, spaced one to two miles apart. They lie



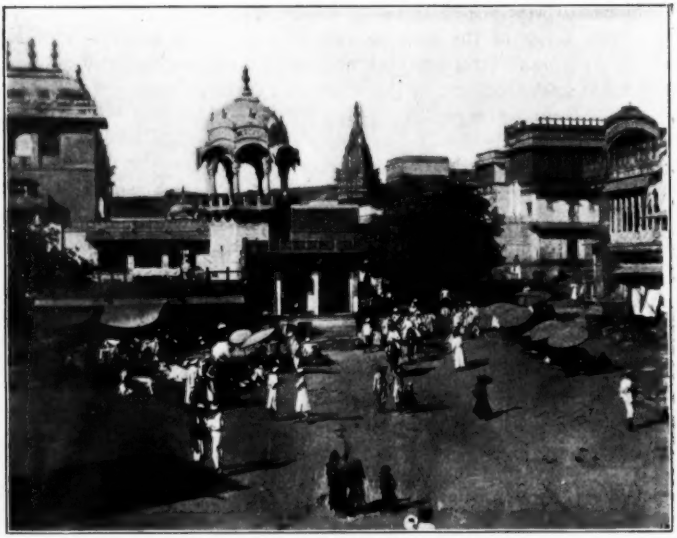
SECTION OF THE DELHI-KARACHI DIRECT RAILWAY.

from east to west, with a dip of 5° to 10° to the north ; and advantage has been taken of the long inclines between these cliffs to form a gathering-ground for a fine tank at Jeysilmir City, where any sudden rainfall is safely secured, as the sheet-rock surface throws off any sudden fall of rain-water rapidly.

The picturesque city of Jeysilmir is built at the foot of one of these cliffs, with its north wall resting on their summit. The fortified palace of the "rawal," as the local rajah is called, stands above the plains on an isolated hill with precipitous sides, overlooking the dull-yellow, stone-built town, with its quaint Hindu architecture. The balconies of the houses, supported by richly-carved brackets, are very

THE COOMAR MAHARAJAH RESIDENCE, JODHPUR.

original and quaint in their treatment. The town is worthy of a visit, as is the larger city and hill-fort of Jodhpur some one hundred and thirty miles to the south-east and accessible by railway from Bombay. Rudyard Kipling gives a very interesting and original account of this romantic Rajput city. Again, some one hundred and sixty miles east-north-east of Jeysilmir and twenty-four miles north of the railway route (at three hundredth mile) is the equally interesting city of Bikanir, the capital of the small Hindu State of the same name. The high walls are some five miles in girth, and the rajah's noble palace lies outside the city walls ; it is one mass of turrets, domes, and projecting balconies. The chocolate-colored stone buildings are similar to those in Jodhpur. Outside these three cities are the ancestral tombs of their rajahs. They take the form of beautiful marble domes, supported by octagonally-planned pillars richly carved and raised on high, square-panelled plinths. The Hindu custom of "Sutti," or the burning of the widows on the husband's death, as many as a dozen at a time, is indicated by upright gravestones placed underneath the dome of each rajah's tomb. Returning to the Mugra coun-



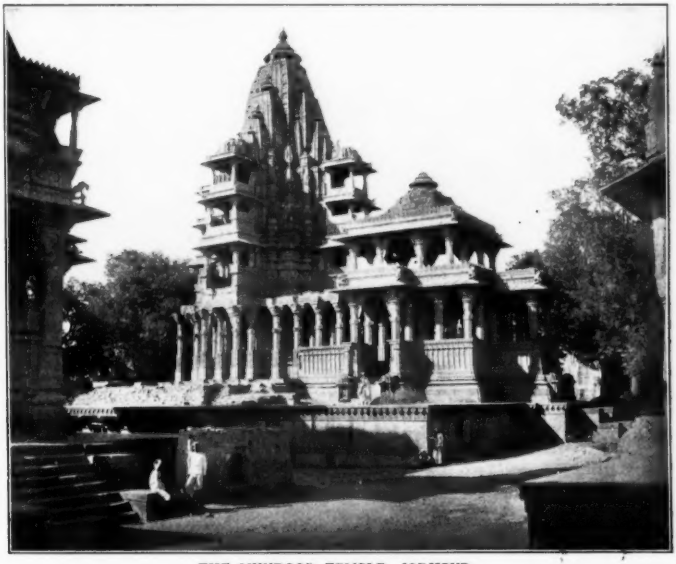
VIEW IN THE CITY OF JODHPUR.

try, it should be noted that, in spite of the scanty rainfall, this sheet-rock area forms a unique gathering-ground for a large reservoir, which can be fed by a torrent discharging in the rains 4,300 cubic feet of water per second for six hours. The nala forces its way through a gorge, and an unsuccessful attempt was made to dam it by the rawal of Jeysilmir. The dam was built of ashlar blocks, easily worked from the surface rock, and set as a dry wall backed by earth.

But, alas for the poor desert State! the first floods breached the dam in many places. It was by chance that the writer noticed the *débris* when riding on camel-back along the jungle track on the first reconnaissance; but, when he had to work out a water-supply for this project, the nala's importance was recalled to his memory by the havoc it had played with the dam. To meet the estimated requirements of the train service it was found necessary to design a reservoir capable of holding 55,000,000 cubic feet of water,—a sufficient supply for six years, the maximum period that the nala was known to withhold its precious flood-waters. By means of a reservoir on a summit near by, water can be supplied by gravity through piping to the railway in each direction, as indicated in the longitudinal section. Pending its completion, the pipe-line would feed the work with water forced up from the Nari river, near Umerkot.

(C) *The "Tiba" Country, or east central section of 140 miles in length.* (Mean height, 700 feet above sea-level.)

This region may be called the "whale-shaped" (in profile) sand-hills area; for, when viewed at a distance, these detached ridges resemble a shoal of huge whales, with their heads and bodies pointing invariably north-east. They also resemble the tip ends of high banks rising out of the plains with a longitudinal slope of 1 in 50, extending in length from a quarter to half a mile and ending in bluffs or rounded ends 60 to 120 feet in height. They are in marked distinction to the Dhora country west of Jeysilmir (section A), as there is an entire absence of defined vallies and cross ridges into which the former merge or die out. Prior to being clothed with grasses, the tip ends increased in height and length by the prevailing south-west winds, which fed their bluffs in the fine, loose sand. It has struck the writer that the Surrey sand bluffs extending from Hambledon and Whitley to Leith Hill, a distance of twelve miles, were originally formed in a similar manner. A plateau of gneiss and schist rocks, twenty miles in width, separates two marked depressions at Chandwan and Bâp, seventy miles apart, in which a constant supply of sweet water is found at the respective depths of one hundred and forty feet. This fact points to some underground supply from a



THE MUNDOOR TEMPLE, JODHPUR.

distance, perhaps as far as the Indus, some hundred and fifty miles to the north. The brackish wells elsewhere are from 240 to 310 feet in depth. Indications of coal and lignite have been found and reported on by the geologists, and even a deep trial-boring has beeen suggested to the government of India.

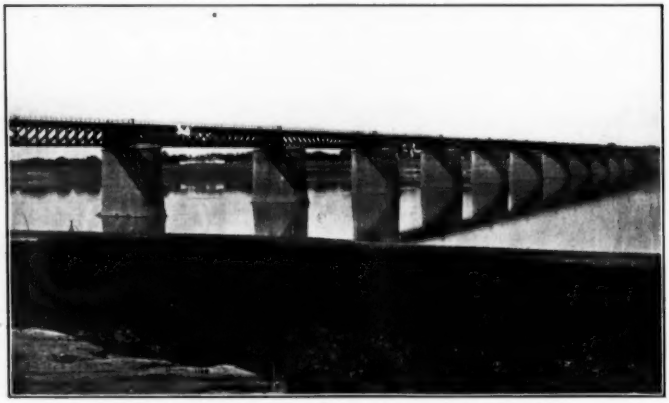
(D) *High level, or west division of 200 miles* (1,100 feet above sea-level).

The western side of this country is the highest on the line, averaging 1,100 feet above sea-level.

The sand ridges are more subdued, rising scarcely forty feet, and the low vallies widen out.

Two conspicuous conical hills, rising five hundred feet above the plains, are remarkable for their old copper mines. It is an interesting fact that a properly-organised line of heliograph signals is kept up from hill-top to hill-top, in various directions, by means of which the inhabitants of Futehpur keep themselves familiar with what is passing in the outer world.

Grasses and dense, thorny bushes protect the surface; among the latter is the "Bher" bush, with its small, red berry, which is a very

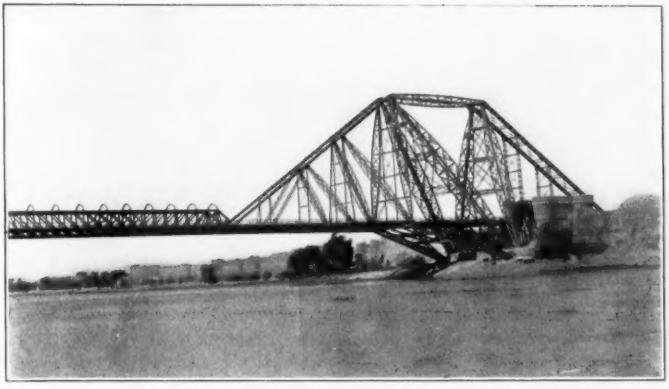


BRIDGE ACROSS THE JUMNA RIVER AT ALLAHABAD.

fattening food for the small, but hardy, sheep reared in great numbers.

The most interesting feature, however, is a shallow lake, the Charwas Jhil (at three hundred and sixty-third mile) some three square miles in area, with two feet of water and containing about 140,000,000 cubic feet. In this case, again, periodical scarcity of water has to be dealt with, but the interval is as long as twenty years. A storage of two years' supply is provided in the estimates, and a reservoir of

30,000,000 cubic feet is proposed. This supply will meet the requirements of two hundred miles of railway, furnishing 76,785 cubic feet per mile per annum, amounting to a total of 15,250,000 cubic feet, having a low-tide supply of the same quantity for the rare exception of a bad or rainless year. At the eastern end of this section the second river occurs, separated by a distance of two hundred and



PART OF THE LANDOWNE BRIDGE OVER THE INDUS AT SUKKUR.

seventy-eight miles from the karkana nala near Jeysilmir. It is 1,200 feet in width, and has a heavy discharge during rains, but the flood-waters lose themselves in the desert sands north of the line. East of Charwas Jhil, and up to Delhi, the water-supply depends on wells averaging 136 feet in depth and 24 feet in diameter, and estimated to hold 40 feet of water,—a capacity of 97,000 gallons, relieving the road of dependence upon slow percolation.

(*E*) *Jumna plains section, 50 miles long* (700 feet above sea-level).

The plains of the river Jumna are now reached, and finally Delhi, nestling between the famous ridge and the glittering Jumna.

The country, now free from sand hills, is well cultivated, and abounds in fine trees and gardens. The line next Delhi skirts the north side of the large Nujagarh Jhil, or swamp, made famous by the decisive victory gained by the immortal Nicholson over the Sepoy army a month or so before the storming of Delhi in 1858.

Having thus reviewed this long stretch of country, attention is now drawn to the grades and alignment of the project.

Gradients. The ruling gradient is 0.66 per cent. (1 in 150), and is confined to the west end of the line over a length of 230 miles,

CHAPPAR RIFT BRIDGE, SIND-PESHIN RAILWAY.

of which 87 miles are $\frac{1}{180}$ grades; 52 miles being with the load or traffic, and only 35 miles against it. On the east side, for 306 miles, the maximum grade does not ascend 0.33 per cent. (1 in 300).

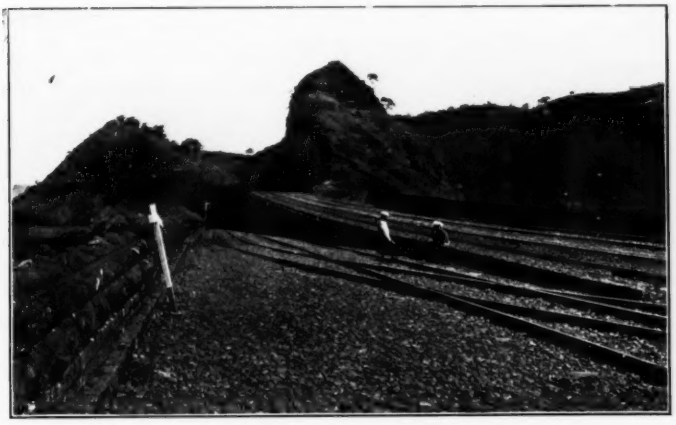
Ratio of gradients (above 1 in 2,000) to total length of line	66.82 per cent.
Average amount of rise per mile	6.27 feet.
Total length of grades $\frac{1}{300}$ to $\frac{1}{180}$, or 38.4 per cent. of length	211 miles.

Curves. Curves of three radii have been adopted, ¼°, ½° and 1° curves, except in three cases a 2° curve, near Delhi, to get round the ridge, and in the sand hills. Compensation is allowed on all curves on gradients against the load to Karachi.

Total length of curves	109.07 miles
Total curvature	3103°
Ratio of curve to length of line	19.8%
Average amount of curvature per mile	5.6°

A few words may now be given to the results of the survey, under the three heads of construction,—*viz.*, bridges and culverts, earth work, and water-supply.

Bridges and Culverts. These are only one hundred and fifty in number, of which ten are 40-span bridges and the remainder 2 to 20-feet, giving 3,118 lineal feet of waterway, or at the rate of 5.7 lineal feet



REVERSING STATION, BHORE GHAT INCLINE, G. I. RAILWAY.

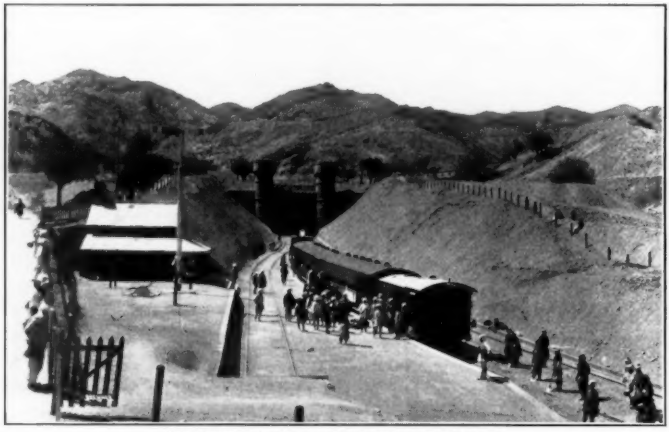
spans, per mile, at an average cost of Rs. 177 (£11) per lineal foot of waterway. The only large bridge is over the kantli nala (four hundred and thirty-seventh mile) consisting of 36–40 spans,—in all, 1,200 feet long, costing £11 per lineal foot. It will be thus seen that the bridging amounts only to Rs. 1,000 (£631) per mile.

Earth work. This amounts to 686,000 feet per mile, or an average height of 4.8 feet of bank throughout. The difficult part of the construction is through the Sind desert for one hundred miles, where it will be necessary to protect the formation and the slopes from the fierce winds, called "Andi," prevailing from the south-west during May and June, when it is absolutely necessary to protect the slopes by sowing grass seeds or planting grasses and bushes. There are more than forty species of grasses alone, not including the hardy trees, named rohira, tamarisk, gumbat, rundiala, and gobal; also the candelabra cactus, and milk, or "ark," bush. It is proposed to divide the surface of the slopes into pockets by placing wattle walls at intervals of 10 or 15 feet apart, square, or perhaps obliquely to the centre line, depending upon the position of the railway with reference to the prevailing winds from the south-west. By this means the sweeping and scooping action of the wind would be broken up.

Several methods will suggest themselves to foresters* for consoli-

* An interesting account of the dunes of Gascony has been written by Lieut.-Colonel F. Bailey, in the *Indian Forester* for January, 1888. See also the notes on the fixing of the dunes, under "Elements of Sylviculture," by G. Bagnoris, inspector of forests at the Forest School of Nancy, published in 1882, as well as Mr. John Gifford's article on "The Control and Fixation of Shifting Sands" in this Magazine for January, 1898.

dating the slopes, and the experience gained in the landes and dunes of Gascony and the Baltic coast of Germany will be of great use in fixing the few sand ridges which are bare. The neglect of precautions, and the result of depriving a country of its natural grasses, are illustrated on the Trans-Caspian Railway, where, from all accounts, long stretches of that railway have become nearly impassable. More-



KHOJAK TUNNEL, SIND-PESHIN RAILWAY.

over, the formation must be protected, for its full width, by a layer of ballast at least six inches in thickness, with which the rail level should be kept flush.

Water-Supply. The two large reservoirs have been already alluded to, but the following information may be added :

ESTIMATE FOR WATER-SUPPLY—PIPES, RESERVOIRS, AND STEAM PUMPS.

	Pipe line.		Rate. Rs.		Rs.
(a)	29,800 tons piping valves, etc., @		105	per ton	31.29,000
	297 miles of laying @		1,320	per mile	3.92,040
(b)	*Reservoirs* (major)	C. feet	Rs.		
	No. 1. Charwas	29,403,000 @	39.115	per million	11.50,000
	No. 5. Karkana	55,000,000 @	39,115	per million	21.51,325
(c)	*Reservoirs* (minor)				
	Nos. 2, 3, 4, 6, 7, and 8, 1804 lineal feet @		100		1.80,400
(d)	*Steam pumps.*				
	16 sets to pump up power				
	60 to 240 feet high from Rs. 1,400 to 5,400				46,725
	Total expenditure for water-supply in desert sections				Rs. 70.49,490
	Equivalent at 1s/6d exchange to				£469,966
	Rate per mile				£1,637

The water-supply, which dictates the working capacity of the railway, is estimated for an average of 14 up and down goods trains, —that is to six trains down, equivalent to an export tonnage of 365 days × 6 trains × 400 tons = 876,000 tons.

It now remains only to conclude with a few remarks on the actual survey operations. The government of India could spare only one of its engineers (the writer) to take charge of the detailed survey. He gathered from all parts of India a temporary staff of engineers and surveyors, who set to work in December, 1889, or within five weeks from the date of sanction. The staff was divided into two parties,— the west and east,—consisting of one railway engineer of experience in charge of the party, with six assistants, or a total of fourteen surveyors.

In addition, a native doctor and fifty to sixty "klassis," or field men, were provided for each party. Special arrangements had to be made for the supply of rations and a water service to the west party in the Sind desert, and it was with the greatest difficulty that the camel men were prevented from deserting, owing to the bad accounts they had heard of the "dura" country. The rate of progress of the field work of the east party, which surveyed from Delhi westwards towards Karachi, a distance of 320 miles, in 98 days, was 3.26 miles per diem, including Sundays. The engineer reconnoitred ahead, and ran the traverse; two assistants were engaged on the longitudinal levels, at 250-feet intervals, in open country, and two native surveyors were engaged on plane table work on the base lines, which included the survey of the hills, villages, nalas, and village boundaries.

The west party (under the late M. Louis Michel, a well-known Scinde, Vangat & Delhi railway engineer), starting from Sufi on Nara river, near Umerkot, surveyed eastwards a distance of 225 miles in 90 days, or at the rate of 2½ miles a day.

This was very good work, considering the rough nature of the country through one hundred miles of sand ridges. The cross-sectioning of the narrow vallies and the digging of some two hundred trial pits also involved extra work.

The rapid completion of this survey was in every way satisfactory, as any delay in the progress would have brought the work into the month of April, when outdoor operations are impracticable, owing to the violent sand storms and hot blasts of wind, which often cause the death of natives. The success may be attributed to the competent and ample staff, and the experience gained in the reconnaissance of the previous year. The longitudinal levelling was particularly good, as, when the two parties met, the difference in the

levels amounted to only 0.15 feet. It was the more satisfactory, as the success of the project depends on a pipe line for the water-supply for two-thirds of the distance,—a length of 360 miles. The office-work occupied the chief, with three engineers and two native assistants, excluding numerous tracers, three months, and comprised printed reports, estimates, appendices, and tabular forms, with five books of index plans and sections, detailed plans and sections 400 feet to the inch, cross-sections of one hundred miles of the sand-hill valleys, miscellaneous drawings, and pipe-line diagram. The complete survey thus occupied the staff but the short period of eight months, from the date of receiving the orders of the government to that of taking up the work.

The cost of the survey amounted to about 64,000 rupees (£4,000), excluding instruments supplied by the India survey department,—a rate of £7.10:0 per mile.

Note.—The estimated total expenditure for 551 miles of railway is Rs. 592,61,753, or a rate per mile, at 1s. 4d exchange, of £7,171. This amount provides for ample rolling-stock to meet a traffic of 2,400 tons daily, but excludes interest on capital during construction.

The illustrations of Jodhpur and Bikanir are from photographs by Shepherd and Bourne, Bombay; those of the G. I. R. and the Sind-Peshin and Mushkaf-Bolan lines (reaching territory northward from Delhi), as well those of the bridges, were photographed by Bremner, of Quetta.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

III.—EFFECTS OF ENVIRONMENT ON THE EFFICIENCY OF WORKMEN.

THE efficiency of the mechanic is, of course, largely affected by his environment, his social life, and his relations to his employer. A genius here and there may raise himself out of his surroundings, and prove himself superior to the accident of birth, but it is practically true of all men that their careers are determined by their environment. Consequently we look for the most efficient men in those countries where environment is most favourable to the development of the greatest number of intelligent and skilful workers. A comparison of the conditions under which mechanics live and work in Europe and in America will throw some light on the subject under consideration. Reference is especially made to the superior mechanic or engineer, and not particularly to the factory hand or ordinary worker outside of the machine shop.

To begin with, children born in the new world have decidedly better opportunties of acquiring a higher education, under more favourable conditions than exist in European countries. Schools of every grade, sometimes even including the universities, are free, and the child of the workman can have an education fitting him for college without a penny of cost to his parents, except what is necessary for clothing, food, and shelter. As a rule, books are supplied to all, free of charge. The subject-matter of education is much the same in all countries, but the important distinction between the school life of the workingman's child in Europe and in America is that the American child, from the beginning to the end, associates commonly with children of every social rank, is brought up side by side with the child of the employer, and has exactly the same educational opportunities and associations. This is not the case in European countries. What is known as the "board school" in England, and as the "gemeinde-schule" in Germany, does not exist in America. The public schools of America are board schools only in the sense that they are supported by the taxpayer; they differ from board schools in being patronized by all classes of society. Secondary schools, high class public schools, and schools for the "sons of gentlemen," in the English sense, are practically unknown in America. The effect is noteworthy, and, I think, beneficial. The children of the American mechanic and of his employer often maintain throughout

life the social relations that prevail in the school, and in the majority of cases this equality lasts till they are fourteen or fifteen years of age, or leave school to work. These relations in childhood are apparently an effectual barrier to the development of those hampering social distinctions so well known and so sharply drawn in European countries. Class distinctions, although they exist, do not operate in America, as in Europe, to impede progress and development among the working classes. The youth of fifteen years may be the chum or comrade of his employer's son. Entering the shop as an apprentice, he has already, through childhood associations, developed ambitions, and is incited to become something better than an ordinary workman. He hopes to become in time an inventor or a proprietor. Such ambitions are crowned with success only in a few cases, but the general effect is the creation of ambitious workers, and a class of progressive, thinking mechanics. The fact that it is not so difficult to rise from the ranks in America as in Europe assists to develop a larger number of good workmen. It is admitted by those who have had the opportunity of observing that it is easier to secure a number of skilled workmen with progessive ideas in America than in Europe. A glance at European conditions will bear out these statements. The average English, German, or French workingman's son, throughout his school life, his apprenticeship, and his work as a journeyman, does not, with but rare exceptions, associate with anyone outside his own class. He is born a workingman and branded a workingman, and seldom thinks of becoming anything else. Elevation to a higher class of living and associations is considered entirely beyond him. The effect of such a view of life is not calculated to produce the greatest number of skilled workers. Not only as a workman are the man's ideas limited, but in his social life he conceives no change or improvement. I am speaking of comparative conditions, leaving out of consideration the small number of workmen on either side of the Atlantic who have clear conceptions of the value of real democracy (which does not exist anywhere) as a means of improving industrial conditions and of securing greater happiness for all. It is a singular fact that, as a rule, European workmen, even to the lowest rank, cling to slavish social distinctions which do not exist among American mechanics. The European mechanic's position in the machine shop gives him a social rank which he is careful to protect, and a recognition which he exacts from all below him, in the same way that he in turn submits to those above.

This condition is not so aggravated in England as in Germany, where, as I am told by the manager of large works, workmen will actually accept less wages when offered a position which is supposed to carry with it certain social privileges, the most coveted of which seems

to be that of forever after looking down on their former associates. This state of affairs does not, of course, permit free interchange of ideas and criticisms, which is necessary to progress and the production of good work. Caste and social distinction in the machine shop effectually prevent the co-operation desirable between all grades of workers. Free criticism from those beneath is not encouraged; complaints, or even suggestions, to those above are not tolerated. The German draftsman is eminently superior to the criticism of those whom he considers beneath him, although in most cases he receives less pay than an ordinary piece-worker. From management to the common laborer, each must consider his social standing above all things, knowing no influence but that of power from those above, and continually seeking an opportunity of exercising his own authority on those below. Undoubtedly the democracy of American engineers, which really exists so far as mechanical matters are concerned (although I am sorry to say it does not in their politics), is of great advantage to them, and will continue to be so, as compared with conditions surrounding European engineers. In principle and in practice American workmen of all grades and positions know no reverence or respect, except for superior ability. They know of no rank which interferes with a free interchange of ideas between workman and manager. This freedom of intercourse allows a criticism, inspection, and control which keep all constantly on the alert to produce work that will bear the closest inspection, and designs that have the greatest number of desirable features.

Having had good opportunities for observing conditions on both sides of the Atlantic, I am convinced that it is possible for the American mechanic to live in social surroundings with more of the refinements of civilization and more domestic comforts than can be enjoyed by the European worker of the same rank. The cost of living, especially of food, has a direct bearing on the productiveness of labor. Mr. Edward Atkinson, in his extremely interesting work, "The Science of Nutrition," states: "As a matter of fact, we find that the rate of wages is highest, or, in other words, the effective earning or productive power of man is greatest, in the United States, where the supply of food is most abundant." American living, as well as American wages, is the cheapest in the world. The slipshod conclusion of most travellers is that, as hotel and restaurant prices are low in Europe, consequently general living must also be cheap. The cheapest living in the world is in the western States of America; there the greatest amount of nutrition can be purchased with ten hours of labor; next come the eastern States; then England; then France and Germany. European machine-shop employees certainly

do live more cheaply than American; they must, as they receive less income and food is less abundant. I feel certain that a more extended scientific research will prove that the non-effectiveness of European labor, as compared with American, is largely due to an insufficient consumption of nitrogenous food, owing in turn to the inadequate purchasing power of the workers. I know from actual experience that food materials, such as are demanded by the machine-shop employee in America, are not cheaper in Europe than in America. This is also true of clothing; although some materials are cheaper in Europe, good workmanship is rarely seen in the every-day wearing apparel of either sex. In every respect household conveniences and fittings are superior in America, of better workmanship and cheaper than those in Europe. This is, of course, due to the higher efficiency of labor, and the more extensive use of labor-saving machinery, by which all articles of manufacture are produced. House rents compare favourably, although European houses, compared with American in equally desirable surroundings, have not as many conveniences. European taxes are an aggravation to all Americans who have had the pleasure of assisting to support foreign governments. Although the lower ranks of mechanical workers in Europe are not heavily taxed by direct assessment, of course the burden which labor must bear cannot be shifted. Mr. Edward Atkinson estimates that national taxes in the United States are equal to 2½ per cent. of each individual's product, while in Great Britain they are 5 per cent. to 6 per cent., Germany 8 per cent. to 10 per cent., and France 10 per cent. to 15 per cent.

The facts of cheap living, liberal education, freedom from class distinction, superior domestic comforts, and lower taxes may seem to have a remote influence on the price and quality of machine tools; nevertheless they are economic conditions which are points of advantage in favor of the American workman, and with them the European must reckon in the world's competition. They are factors which assist to produce better workmen, with whom Europeans cannot compete unless their workers receive such wages as will enable them to enjoy equal conditions, and to live in equally favourable surroundings. I have heard it remarked by more than one European proprietor—men who were thoroughly acquainted with modern methods—that they simply could not consider the adoption of many improvements which they knew to be right, for the sole reason that such changes conflicted with the customs and conventionalities they live in. Of course, continental Europe is always at a disadvantage in the commercial race on account of the military service exacted from all. From one to three of the best years of a worker's life must be spent in the army.

This service is exacted at an age when men are by nature best fitted to learn and to become skilful artizans. As Mr. Atkinson states, "the power of production of France and Germany is minus the nine hundred thousand men who are wasting their lives in camp and barrack." This state of affairs may be unavoidable under the present circumstances, but, at the same time, I do not believe Germany realizes what the curse of military service means to her commercial progress. Aside from the expense of supporting an immense army of non-producers during their military service, she has to reckon with the evil influence of military training, both in the office and in the shop. Senseless bureaucratic ideas, which have their origin in military organization, pervade all. The educational system, the workman's sense of duty, the manager's conception of discipline and organization,—all is military. "Obey orders and ask no questions" seems to be the dictum of the machine shop as of the army. This, of course, is wrong. Machine-shop employees must be trained to become thinking units, not mechanical puppets.

I would by no means depreciate the moral character of the European mechanic, but certainly his standard of living, the care which he gives to his personal appearance, and the general condition of the shops in which he works, contrast unfavorably with those which the American mechanic enjoys. Propitious surroundings have, of course, an immeasurable influence on the efficiency and progress of the workman, and it is interesting to contrast the conditions, as we find them in European and American shops, in this respect. Take washing facilities, for instance. No American shop is too mean to provide for its men in this manner. In many cases factories are fitted with washing-rooms, appliances by which each workman is supplied by a running stream of water, and separate lockers for clothing. The American mechanic, as a rule, has working garments in which he never appears on the street. He never leaves the factory without washing and making a complete change of clothing. There is a marked difference between the appearance of the men emerging from an American engineering establishment and that of those leaving the average European shop. In this respect the continental worker is in advance of the English mechanic. In many continental factories I have seen good washing appliances, which are always used by the men before leaving. In almost every respect the European proprietor pays far less attention to the surroundings and comforts of his work-people than does the American manufacturer. It is rather the exception to see a thoroughly heated, lighted, and ventilated European machine shop. High-grade work and fine mechanical production require the best of surroundings and the greatest comfort for the worker.

Particularly is this true in working metals, as it is impossible to work in badly-lighted, poorly-ventilated shops, with benumbed fingers and cold feet, and turn out a really first-class product.

In considering the various causes which go to produce good and bad workmen, I have avoided the question of technical training, of which we hear so much at present, for the reason that technical education is not available to the great number of workmen, and consequently has little to do with the matter under consideration. In the manual training schools, however, I am looking forward to important results; but, at present, they are of comparatively little importance to the majority of workers. I am sure that, in either European or American machine shops, a very small number of the workers have had the benefit of manual training, or of technical education. It is well known that men of purely technical training, without practical experience, are of little use to the mechanical engineer. It is no recommendation to the proprietor of an American machine shop simply to state from which college one is a graduate. I believe that the majority of the best mechanical engineers in America have no college education. College training should not unfit a man for practical machine-shop work, but, as at present carried out, it seems to be a fact that it does. As far as the American situation is concerned, a corrective dose of five or six years' work in the shop seems to be the only cure for the college graduate. With respect to the European technically-educated engineer, particularly the German product, it is still more difficult to make him realize the value and necessity of practical training for those who would design or superintend. It would be well for those of other nationalities, who are at present looking at the German technical schools with a jealous eye, to endeavour to ascertain if the results attained in that country are wholly desirable.

The ability of a mechanic is, of course, largely influenced by the apprenticeship under which he may have served. By the European method the apprentice is usually trained in one class of work,—that of turner, planer hand, fitter, or whatever line he may have selected to learn. The American apprentice usually has an all-round training, and is generally allowed to work in every department of the machine shop, and, in many cases, in the drawing room as well. This all-round training produces mechanics who, by reason of their experience, can adapt themselves to various classes of work. At the same time, they can work more intelligently in whatever branch they may finally adopt as a calling, for the reason that they have a knowledge of other classes of work, as well as their own. The economical manufacture of machine tools, as of other articles, calls for a division of labor, but is peculiar in calling also for special training in the various

operations. The cheapness and accuracy with which one operation can be performed are, of course, largely dependent on the thoroughness of the preceding operation. An operator must be able to judge of the previous workmanship on a piece of mechanism in order to determine whether he receives it in a proper condition. And acquaintance with succeeding operations assists him to perform his own work properly. The American apprenticeship system fulfils these conditions, which are conspicuously wanting in the European. This is of unquestionable advantage to the American maker of machine tools, particularly as it produces a greater number of that valuable class of workers known as "tool makers," which, judged by the American standard, practically does not exist in Europe. It has been the uniform experience of American engineers with whom I have come in contact, who have had occasion to employ European workmen, that the European is totally at a loss if he has to tackle any problem for which he has not been trained, or that deviates to any extent from his routine work. The boasted superiority of thorough English workmanship is a myth. The thoroughness for which the German is phenomenal, in some respects, surely does not hold good as far as mechanical operatives are concerned. I have had considerable experience with all classes of European workmen,—carpenters, masons, foundrymen, machinists,—and I must say that there is a conspicuous lack of appreciation of good work among them, and that the use of primitive tools and methods is common. These deficiencies are largely due to bad supervision and want of intelligent management. Corresponding classes of workmen, under more favourable conditions and better management, form a large part of the best mechanics in America. It is a fact, verified by statistics and the statements of many American makers of machinery who have successfully introduced their machines into European countries, that, under European conditions and when handled by European workmen, American labor-saving and automatic machinery turns out from 30 to 50 per cent. less than is produced by the same machinery in America. I am told that the royalties on the McKay boot-stitching machines, paid on the products turned out, are one-third less from the machines in operation in European countries than from those in operation in America. I know that, on certain machines for the production of bicycle parts, operations which are regularly performed in America in from six to seven minutes usually take from ten to twelve minutes in the hands of European operatives. This is due chiefly to inefficient labor and the want of properly-trained tool makers to keep the machines in a high state of efficiency. It is also stated that the product of the Singer works at Glasgow is no greater than that of the works in

America, although they employ one thousand more operatives. The German is not as thorough a workman, taken all round, as the Englishman, although he has qualifications which, in combination with the adoption of new methods, are fast putting him to the front. He works harder and longer, and is more receptive of new ideas. German technical education, which at present seems so formidable to the Englishman, should really create no apprehension on the part of a competing nation, particularly so far as any influence it may have on the machine-tool business. It serves to carry the student so far into the consideration of the theoretical that, as a designer, he is apt to ignore practical results. This fact does not, of course, condemn technical education, but rather the way in which it is carried out. The most glaring faults of technically-educated men seem to be their utter ignorance of, and way of ignoring, the working details necessary to execute their designs. They make the most elaborate and exhaustive calculations, working out the most intricate problems in the most minute details, and make drawings that are monuments of painstaking care and works of art to look at. The consummation of the reality is accomplished in another world, to which they are strangers and with which they have no intercourse. Work should be supervised by those who have a knowledge of the end desired and of the results to be accomplished. As a rule, the German technically-educated man does not seem to have the spirit of practical investigation which is necessary to the best results. When he has made his fine drawings and elaborate designs, his work is done. The rest is left to poorly-paid labor, which, naturally, has little interest in the successful issue, and no comprehension of the end in view. This is in marked contrast to American methods, where control and inspection of workmanship on the part of designers is considered of as much importance as the design itself. Of course, this method develops more efficient workmen on the one hand, and more practical designers on the other. The workman has the benefit of coming in contact with the supervising skill and advice of highly-trained minds. The technical man comes in contact with the reality of form and operations, which cannot be learned from the "books." In European countries the influence of social conditions and military training maintains this isolation of workers, which the introduction of labor-saving machinery alone will not break down, and, for a long time to come, this will work to their disadvantage in competition with America.

In addition to the ordinary influences of social customs and shop training, the English mechanic's ability is largely controlled by the trade union. The recent engineering strike has so thoroughly disclosed the evils of trade-union tyranny, and has so clearly shown

that many of the defects and inefficiencies of the British workman are alone due to its influence, that but little comment is necessary. Trade unionism, as it exists in England, is but the concomitant of class distinction, in the same way that Socialism in Germany is the concomitant of militarism. It is a weapon of defence of one class against the oppression of another. Although England leads the world in political freedom, the support which she gives to trade unionism is evidence of social rot. The work of the trade union should be to eradicate this rot, not to fight industrial progress. It should not try to restrict the number of machines one man can attend, to limit the number of apprentices, to fix the rate of wages, to restrict one man's output, and to determine the hours of labor. It should seek rather to bring about those conditions of social and economic freedom under which an individual can work as long as he likes, attend as many machines as possible, produce his utmost, and receive the full reward of his efforts. Trade unionism in England is on the wrong scent. The British workman is his own worst enemy. It would not be true to say that the American mechanic has a better understanding of economic problems than his British brother,—the fact is, I believe, that he has not as good,—but he is surely at present working under certain conditions of freedom that are of immense advantage to him in competition with other nationalities. I am not acquainted with one American machine-shop employee whose work or progress is influenced by any organization or society. I cannot call to mind an instance of a first-class American mechanic who is a member of a union. The development of individual talent requires freedom from rules and restrictive influences. This state is more nearly approached in America than in Europe. It is obvious with whom the advantage lies, as the following instance will show. A large American manufacturer is sending large quantities of a superior article to England. That shipments may be made in a more compact form, he has established works in England for putting together parts machined in America. On a recent visit to the English factory, he observed the manner in which the work was done. Calling the foreman to one side, he told him that he could show the workmen how they could, with the same effort and working the same number of hours, earn from 25 to 30 per cent. more in wages, and asked if it would not be advisable to do so. The foreman thought it was a good idea, and spoke to the men. On calling next day, much to the surprise of the American, not a man was at work, and it was three days before work was resumed, and then only on the condition that no innovations would be attempted. It is also of interest to note that the wages cost of the work turned out of the above factory is more than double the

wages-cost of the same product in America, though the American workman receives 50 per cent. more than the Englishman. Trade unions in England are certainly doing good work in their efforts to abolish half-time child labor, to reform the conditions surrounding woman labor, and to solve the land question, but they show little understanding of commercial conditions or of modern manufacturing requirements.

I can hardly believe that manufacturers and workmen realize the time they lose by the peculiar division of the hours of labor which prevails in many European workshops. Work is begun at six in the morning. Rising at an early hour, there is perhaps little inclination to start with a substantial meal, on account of limited time. To get a full head of steam with a scanty amount of fuel is difficult. Work continues for two hours; then half an hour is taken for breakfast; then work starts again, and is kept up for three hours; then a stop for dinner, after which work is resumed. In England tea is allowed in many shops in the middle of the afternoon, and nearly always in the offices. The continental worker is usually allowed to eat twice during working hours,—in the middle of the morning and the afternoon; beer is also allowed during working hours. Taken all round, the European worker is at a disadvantage compared with the American, as so much time is consumed in stopping and starting, in eating sandwiches, and in drinking beer and tea during working hours. It is impossible to produce as much work in the ten hours in this dawdling, nibbling fashion as can be turned out in straight-away runs, under full steam, with good fuel and plenty of it. Estimate the time wasted in one day for the breakfast-hour alone, in an English workshop where one thousand men are employed. Is it an exaggeration to say that ten minutes are lost at this time by each individual? For one thousand men this is, say, 160 hours per day; in a week, 960 hours. At 6d. per hour, it amounts to £24. Messrs. Smith & Coventry, of Manchester, have recently adopted the American practice, doing away with the breakfast hour, and they find the change satisfactory. The American mechanic begins the day with a substantial breakfast, starts work at 7, works without stopping till 12, has an hour for dinner, and works again from 1 to 6 without stopping. No beer, no tea, no sandwiches. Well-fed, steady working. Which has the advantage?

The net results of environment, education, social life, and habits are certainly in favor of the American mechanic. The American conditions produce more active workers, unhampered by the traditions, customs, and conventionalities which exist in older countries. Individuals have a more serious interest in their work, and there

exists a desire to improve on the part of the lower-grade workers, side by side with the finer and more highly productive mechanic. The American mechanic has little interest or inclination to make his work "hold out." He knows that his wages and promotion are dependent on producing the greatest quantity in a given time. European mechanics, on the other hand, are hampered by established customs and class prejudices. One's lot is accepted as a decree of fate which cannot be altered. There seems to be a tacit understanding on all sides that the exploitation of labor is a matter of course. The consequence is that workmen have little interest in improving, or in becoming more highly productive, and feel that reward for special effort simply enriches their employer, while their own condition remains unchanged. Employers, expecting no extra exertions on the part of workmen, mainly direct their efforts to keeping the wages account as low as possible. What can European manufacturers do to compete with superior conditions which exist in America? A complete social revolution is out of the question, or too remote to be of practical consideration. I know, however, that successful efforts are being made by several large concerns to improve the conditions surrounding their workmen. They must exert themselves to create such conditions in their works that the objectionable ideas which tend to defeat the end in view—*i. e.*, the development of the greatest number of intelligent workers,—cannot thrive. As a first step towards raising the standard of work, I know several European companies which are engaging American managers, foremen, and workmen. Where works are large enough, great improvement can be made through better organization, a good system of apprenticeship, well-arranged shops, and high wages, in spite of discouraging outside influences. An independent standard can be established which will characterize such establishments, and give them such a name that only the most desirable elements will be found within their walls, or will seek to enter. Europeans have other problems to solve, aside from that of becoming good copyists of American designs. Economic conditions, as well as factory organization and new methods, must be studied by both employers and workmen. On the other hand, Americans should realize that time is liable to fetter them with the institutions that hamper industrial progress in Europe; they are already founded, some of them are flourishing, and political conceit and ignorance are nursing their growth. Unlimited resources, highly-developed machinery, and efficient labor will not alone prevail. Although few admit it, the coming problems for Americans are political, not industrial.

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

IN wood-working processes the first in order is the conversion of logs or balks into merchantable sections, called planks, boards, scantlings, or deals, by what are called saw mills. Unlike the other operations of wood-converting, which are effected on both sides of the Atlantic by machines directed to the same purposes, log-sawing presents a distinction so great that it is expedient to consider American and European practice separately.

Machinery for log-sawing has been extensively changed in the United States during the past thirty years, having been more than doubled in capacity and gradually directed toward greater economy and an avoidance of the waste that formerly shocked the people of other countries.

At the Centennial Exhibition of 1876, I accompanied some Russian officers to see an American circular saw mill in operation there, feeding at some forgotten rate, cutting out a kerf of about three-eighths of an inch and producing surfaces that can be imagined. It was considered admirable, according to American ideas of sawing timber, because of the "speed." The Russians, with some other foreign engineers in the party, gazed in wonder at the performance, and, after a short time, the chief officer exclaimed: "Horrible!" whereupon they all turned away and left the place. Several years later the subject was discussed with this same officer, who said the waste of timber and the rough character of the work seemed to him "barbarous." This circumstance led to a tolerably complete examination of timber-sawing and of the causes of so wide a divergence in methods between the United States and other countries.

Inventions and changes in this class of machinery in the United States, where they have been more numerous than anywhere else, have been the result of two causes: one, the custom of sawing timber to merchantable dimensions when green, in forest mills,—a "single reduction," so to call it; the other, an effort to attain speed of performance, instead of economy of material and good work. These things are sequences of certain local conditions peculiar to North America generally.

Timber is cheap, plenty, and of a wonderfully fine quality. Labor, machinery, and capital are dear. Waste in sawing, by reason

of wide kerfs and irregular dimensions, is not much considered. Some idea of the difference between the United States and Europe in the matter of cost of forest timber can be gained from the fact that formerly there was a large trade in balks of walnut and poplar or tulip wood, felled and squared in Indiana, transported by rail to

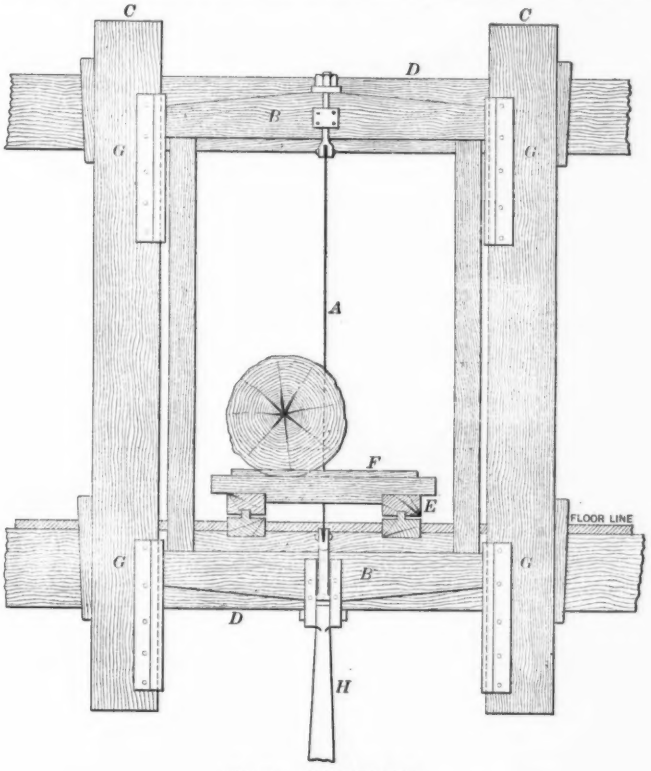


FIG. I. SASH SAW MILL.

New York, sent across the Atlantic, and again transported by railway to European cities, to be finally sawn into dimensions for use. Such timber is sawn into one-inch boards with a loss not to exceed a twelfth, while, if the same timber had been sawn where it was felled, one-third—or more, if circular saws were used—would have gone into sawdust. Not all the waste, however, was due to this symtem of forest or green sawing; warping, breakage by handling, dam-

age by grit and stains incident to seasoning, and loss from irregularity of dimensions, amount to more than twenty per cent. of the original cubic contents.

This single-reduction system extends even beyond the sawing of logs to finished dimensions. In some cases on the Pacific coast, for example, flooring, ceiling, weather-boards, and the like are planed green, from the log saws, and are so supplied to the merchant-consumer. There have been, no doubt, economic conditions of a local nature that rendered these wasteful methods expedient, but such conditions no longer exist, and the present tendency, as will be shown, is to greater economy.

Sawing to dimensions in forest saw mills continues yet, mainly by reason of custom. The timber dealers require immense yards, in which are stored timber of all dimensions, piled up as it comes from the mills. Few of these dealers have machinery to cut out orders to accurate dimensions, as is the custom in European yards, where the stock usually consists of three kinds, or units,—logs, balks, and deals,—from which orders are prepared as wanted.

With this brief explanation of the conditions that have attended upon the evolution of modern log-sawing machinery in the United States, and without which explanation it would in various respects contrast unfavorably with European practice, I will proceed to notice the mills* themselves, beginning with the old single sash saw—the primitive form employed all over the world, and yet to be seen in many places on both sides of the Atlantic, where a small amount of sawing is done to supply a local demand. As there are no available illustrations of sash saw mills at this day, an explanatory diagram, Fig. 1, is shown here.

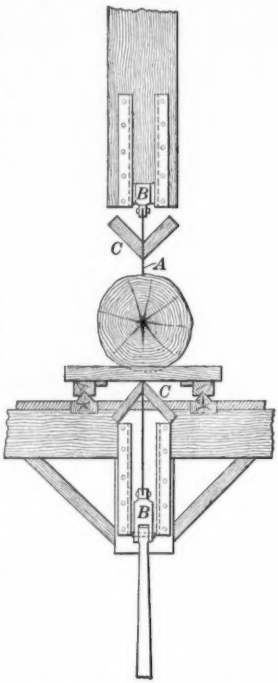


FIG. 2. A "MULEY" SAW.

A is the saw; B, the sash or frame

* The name "mill," which comes from the association of timber-sawing with grinding mills, seems irrelevant when applied to a machine, but is no more so than the term "frame" employed in England; besides, it has some warrant in the fact that sawing-machinery was formerly, and is yet to some extent, built in with mill buildings, constituting a portion of them.

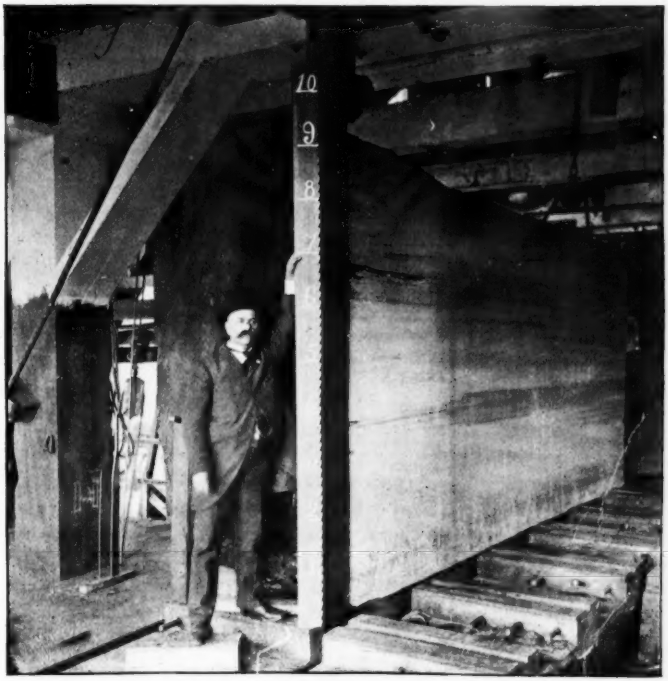


FIG. 3. EXAMPLE OF DEEP SAWING.

Showing cut, 9 ft., 6 in., deep, made with an E. P. Allis band-saw mill at Eureka, California; a fair average example of the heavy balks which can be cut only by the band-saw mill. Before the introduction of band-saws there was great waste of valuable red-wood lumber on the Pacific Coast, the logs often requiring to be split by charges of blasting-powder before they could be handled by the circular saws.

in which the saw is strained; C, C, fender posts; D, D, fender beams; E, the carriage; F, the head block. The whole structure, except the guides, G, and the forged "saw irons," is made of wood. The connecting rod, H, extends to a crank, commonly on one end of an engine or water-wheel shaft. The number of strokes is about 150 per minute, which makes a cutting movement of 300 to 400 in the same time, and the capacity is about 2,000 feet, board measure, in ten hours.

The first departure from the frame or sash saw system occurred in the Middle States about 1848, when "muley" saws were introduced. It was a bold innovation, having for its objects a reduction of weight

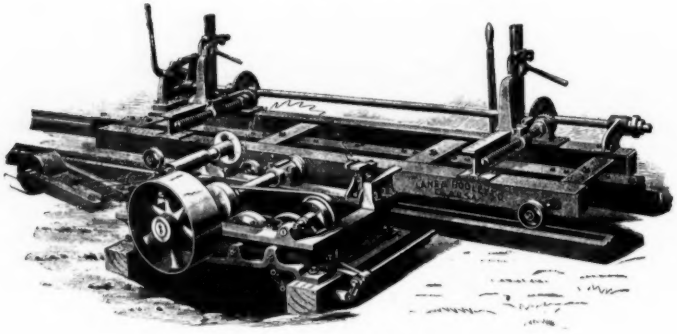


FIG. 4. AMERICAN PORTABLE CIRCULAR-SAW MILL

Arranged for single circular saw, and showing feed works, and carriage with fractional head blocks.

in the reciprocating parts and an increase of speed. The speed was more than doubled. The method is illustrated in Fig. 2, where A is the saw, unstrained, and supported at each end by light cross heads, B, B, by the guides C, C, above and below the log, and by the log itself after the saw enters the wood. Other parts correspond to the sash or frame saw mills.

The speed was from 350 to 400 double strokes per minute, or from 700 to 800 feet of cutting movement. It was a bold scheme,

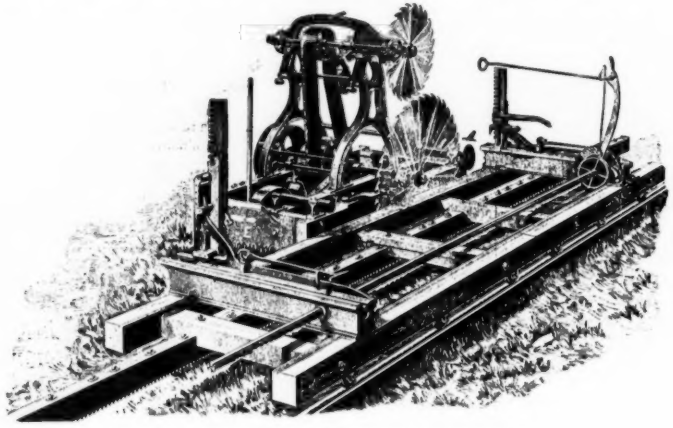


FIG. 5. PORTABLE DOUBLE CIRCULAR-SAW MILL.

Arranged with top saw, for deeper cutting than is possible with a single circular saw.

peculiarly American in its conception, but it soon disappeared when circular saws came in with a continuous cutting motion of 6,000 to 9,000 feet per minute.

An extraordinary feature in the "muley" sawing system was that in some cases the mills were single-geared to steam engines running from 350 to 400 revolutions per minute, and were the first examples in actual practice of such a speed of rotation. Later engines were directly connected to the spindles of circular saws running at a speed of 500 to 600 revolutions per minute.

This unstrained method of operating reciprocating saws lasted only a few years, and then began to decline—not to end altogether, however; it came in again about twenty years later, in connection with scroll saws, as will be noticed hereafter, and was again defeated by the substitution of continuous-acting band saws. In this connection it may be mentioned that the capacity of saws is a function of the rate of the cutting movement of their teeth. There are other limitations of a mechanical and operative nature, especially in respect to endurance and the effect of reciprocal motion, but the rule holds in a general way; in fact, it is obvious, if we assume a constant duty of the teeth. At first thought it will seem that there could scarcely be comparison between reciprocating and continuous acting saws in respect to the speed of the teeth, but this is not the case. Strained gang-

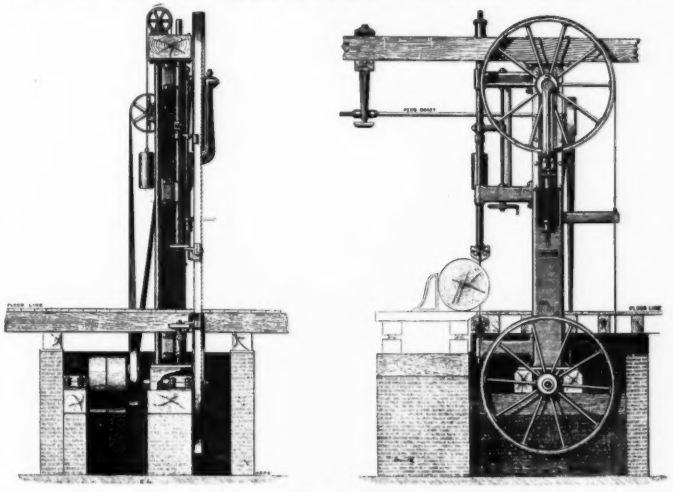


FIG. 6. EARLY BAND LOG MILL.
Built at the Atlantic Works, Philadelphia, 1872.

saws are capable of performing more and better work because of their rigidity, and a cutting movement of 4,000 feet per minute can be attained by a gang of saws cutting eight to twelve kerfs at a time.

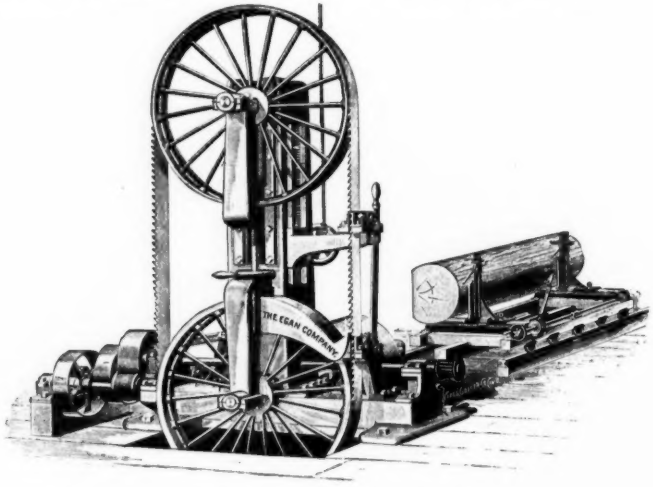


FIG. 7. AMERICAN BAND-SAW MILL.
Showing arrangement of carriage and feed driving gear.

Following and displacing the muley saws came the circular-saw era that has lasted to the present time, but is now being succeeded by band saws. They supplied a supposed necessity for greater speed of cutting, but the performance is, as the Russian officer described it, "barbarous," if we consider the kerf-waste, rough surfaces, and inaccuracy of dimensions. They supplied a want, and suited the peculiar circumstances that exist in America. Such machines are cheap, rapid in performance, and portable; they can be erected in a few hours, and for this reason can be moved from place to place as the timber is cut away.

These conditions are peculiar to circular saws, and account for their wide use in common custom sawing. In addition to this, they are suited to some kinds of work, such as sawing taper pieces for telegraph supports, short pieces of any kind, and slabbing or squaring logs. Their principal features, however, are portability and cheapness, and this has caused the American circular saw mills to spread widely over the world, especially to southern parts.

Circular saws have certain inherent limitations. Their rigidity

diminishes with their diameter and the dimensions of the work they have to do,—just the reverse of the requirements. They are unstrained,—"loose" is the usual term,—depending for lateral support on the stiffness of the plate, aided to some extent by centrifugal tension at high speed. For this reason the thickness of the saws has to be increased with their diameter, which has a limit of about seventy-two inches.

Deducting the saw collars from half the diameter, and allowing for some clearance at the top leaves, a cutting depth of thirty inches or less is left for a saw six feet in diameter,—practically twenty-four inches, which for American timber is far below the requirements. This led to a use of a second, or top, saw to act in the same kerf and

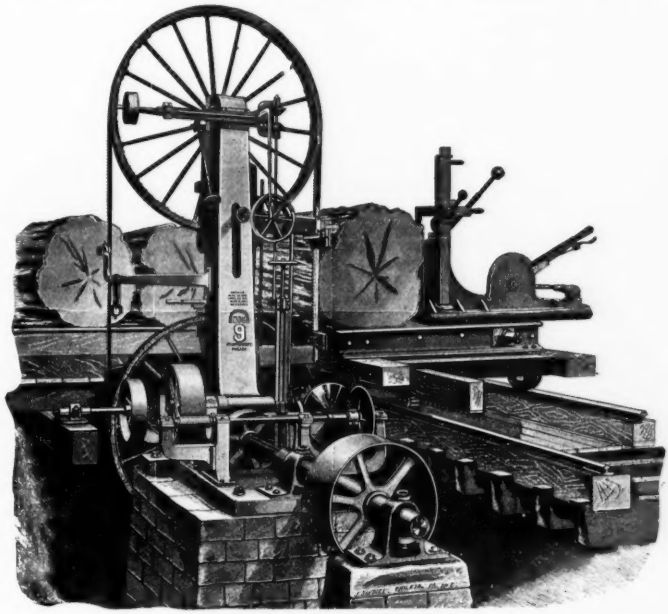


FIG. 8. AMERICAN BAND-SAW MILL.
Showing general arrangement for heavy log sawing.

in alignment with the main saw,—a device that made still rougher surfaces, but answered the purpose; it is a common type in the United States.

The kerf waste in this system of sawing is enormous. Some meas-

urements made at Portland, Oregon, some years ago, showed kerfs of 0.36 to 0.40 inches, amounting to a loss of 15 to 20 per cent. of the timber in excess of what would have been lost in sawing with band or gang saws. This is probably unusual, but in some tables at hand,

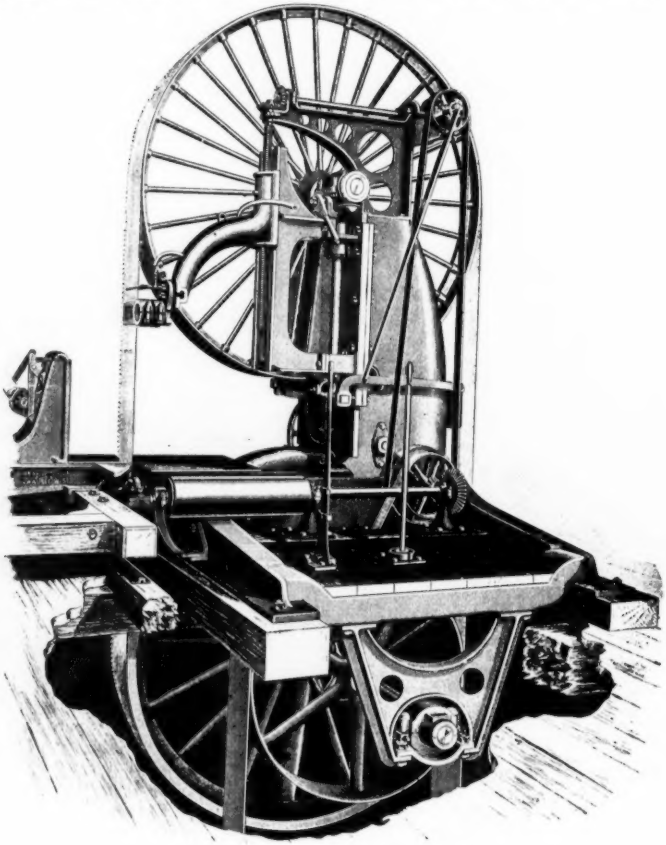


FIG. 9. AMERICAN BAND-SAW MILL.
For heavy log sawing, with a minimum kerf.

compiled by a reliable firm, the difference of waste between band and circular-sawing of one-inch boards is set down at 21 per cent.

A good deal of the waste with circular saws in all kinds of sawing comes from the want of proper lateral support for the saw plates,—a

matter that seems to be almost wholly neglected in American practice. This will be further explained hereafter.

Band saws for logs on heavy sawing, now in course of vigorous evolution in the United States, furnish a fair example of the tedious course of development through which even the most simple implements and processes must pass before settling down into successful use. All such things have to be tentatively learned through years of experience and by a consensus of knowledge and effort.

There are many who can remember difficulties encountered at first in the operation of circular saws for log-sawing; it was sometimes questioned whether such saws could be operated without deviation from their course. After a time there began to appear sawyers who could manage the matter. They received high wages, and their occupation was a mystery; but this soon passed away when it was discovered that the saws should not be guided from their centers or by the spindle, but by guides near the teeth at the front.

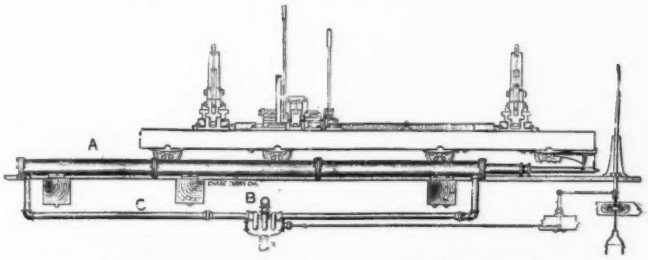


FIG. 10. DIRECT STEAM FEED FOR SAW-MILL CARRIAGES.
Used in connection with band- and circular-saw mills.

The same difficulties, but in a greater degree, came up in band saws for logs. The teeth at first were made short and close together, because the saws were thin and the gullets or spaces between the teeth could not contain the sawdust. Setting was done by bending the teeth, which was not at all a practicable way, and no progress to speak of was made for a long time. Fracture was a common result.

In the multifarious uses of steel there is perhaps no case where it is taxed as severely as in band saws. A log saw has a section representing about a half a square inch, which has to withstand a tension of 1,000 to 3,000 pounds, and bend through a curve of 180 degrees from 600 to 1,000 times in a minute, and which must have qualities and temper to maintain cutting edges; and withal it must undergo a continued change of temperature. The wonder is that any kind of material and care can maintain such an implement.

Band saw machines were definitely invented ninety years ago, and put into a practical form, as the illustration will show; but the discovery was of no use without serviceable saws, which could not be produced at that time, or for long after,—thirty years or more, when M. Perin of Paris succeeded in producing saws and machines that, at the first Paris Exhibition, won for him a principal award by the

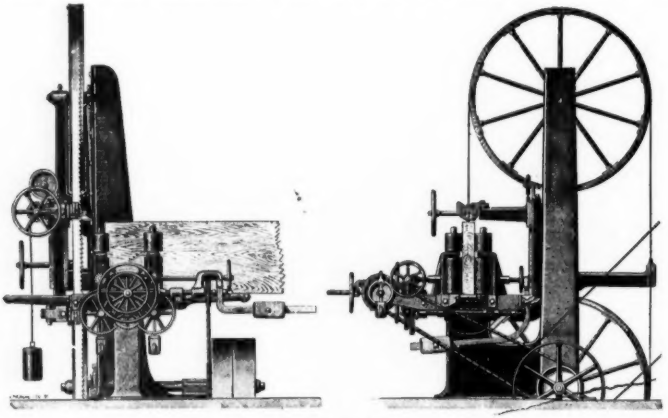


FIG. 11. AMERICAN BAND RESAWING MACHINE.

French government. He went on increasing the size of the machines and saws, until about 1868, when log-sawing was attempted with some success, but not in a manner to meet American requirements, except for special kinds of work. The saws were operated under high tension, and the cutting rate was so slow that the sawdust was reduced to a fine powder.

In 1869 two of M. Perin's band saws were brought to New York, erected at the foot of Tenth street on the East river, and applied to cutting fine timber of large size—balks of walnut and tulip wood that were sawn into wide boards for piano-tops and other like uses. The boards were cut smoothly and accurately, but at a slow rate; for valuable timber of this kind the speed did not matter much, but the machines are incapable of common sawing at a commercial rate.

In 1870 the writer's firm at Philadelphia contracted with Mr. George Law, the celebrated engineer who built the Panama Railway and the High Bridge at Harlem, New York, to construct a band sawing machine to receive saws 48 feet long and 6 inches wide. The main object of the machine was to saw dock planking,—logs sixty feet long in some cases,—following the shape or curves of the timber.

Other machines soon followed, two of them for the Central Pacific Railway Company; they were made in 1872, and are yet in use, —one of them at Sacramento, Cal.

These machines were not as large as the first one at New York, but were self-contained, made of iron, and, in all essential features, as complete as any that have succeeded. They are illustrated among the drawings.

From this point on there was steady progress in band sawing logs, both in the United States and in Europe, especially in adapting the saws to rough work, which has been done mainly by American saw-

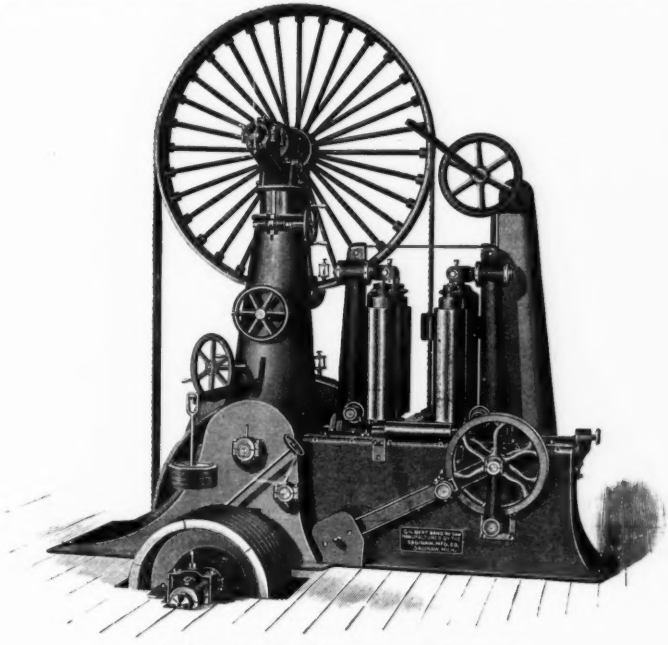


FIG. 12. AMERICAN BAND RESAWING MACHINE.
The timber is fed between the vertical feed rolls, and resawn to exact dimensions.

yers. The use of water on the saws has proved of much advantage. It keeps the saws cool and prevents changes of temperature, also tending to wash out the saw-dust.

It would be tedious to go over the various details that have arisen in the development of band sawing. Some of the most important are as follows: improvement in the quality and temper of the saws; the

alignment of the wheels by adjusting their shafts in a horizontal instead of a vertical plane, and thus avoiding flexure of the saws edgewise; change of the form of the teeth, and better sharpening, preventing back thrust on the saws; setting the saws by swaging, instead of bending the teeth; reducing the weight and momentum of the top wheels, so as not to slacken the saws when they enter the wood; use of water on the saws to maintain uniform temperature, and assist the escape of the sawdust; and, above all, the skill born of habit, empirical knowledge of what is required in order to succeed.

A successful band sawyer can not instruct others how to do his work, or put the matter in words at all, but he can keep his saw going, and avoid accidents to the saw and machinery.

In respect to design and construction there has been among American makers a strange recurrence to the original French idea of framing —consisting of a kind of bench for the top wheel and its accessories, which construction has some advantages to offset an ungainly design. The main object is, no doubt, to save metal in the frames, and to enable them to be made in pieces and bolted together. The illustrations show what is meant.

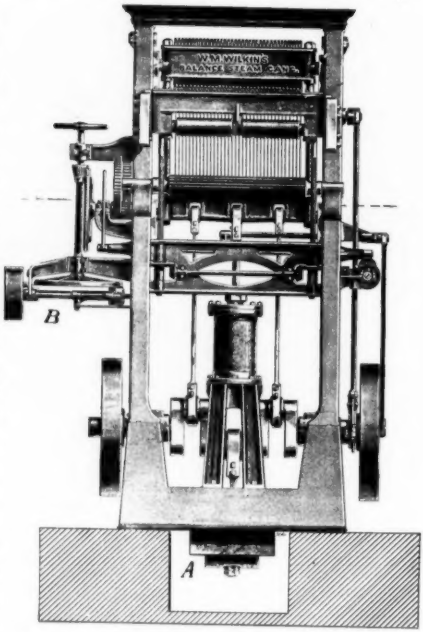


FIG. 13. AMERICAN GANG MILL FOR LOGS.
With direct steam driving, and opposing reciprocating counterbalance.

The future of band sawing is hard to foresee. The speed of performance is marvellous. A thin saw moving at one hundred feet a second has scarce a limit of cutting rate. In reports at hand on the performance of machines, some of the statements seem incredible. The amount of timber, reckoned by board measure, is from 20,000 to 80,000 feet per diem. In one case the average amount, for fifteen

consecutive days, was 200,000 feet a day in hard woods, the band-saw having thus fully equalled the performance of the circular-saw.

Band saws are applicable to rough work, such as squaring or slabbing balks for gang saws, and, in one case reported from Clinton, Iowa, a band sawing machine squared an average of 130 logs a day for two and a half months consecutively.

Band resawing machines, for second reduction, as practised in the United States, usually after the timber is seasoned, have been the most difficult of all to bring into practical working form, especially for sawing the soft, spongy kinds of wood. Slow feeding dulls the saws out of all proportion to the amount of work done, and fast feeding causes deviation through packing of the sawdust. It may be said that the result would be the same with any kind of saw,—which is true, supposing the thickness the same.

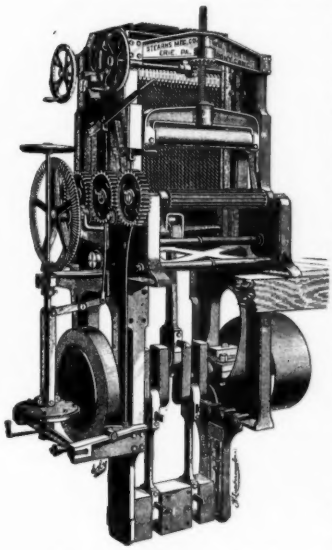


FIG. 14. LOG GANG-SAW MILL.
With roller feed and reciprocating counter-balance, variable friction feed, and belt driving.

The projection of teeth, and consequently of the dust space between them, is as the thickness of a plate. The lateral rigidity of the teeth also depends upon their thickness; so, the thinner the saws, the more difficult it is to operate them in deep sawing and in dry timber that contains soft pitch or is of a fibrous nature. A wide pitch, or space between the teeth, is best, and a curve under, or in advance of, the teeth is better than an acute angle.

It is, however, to be questioned if band saws are as suitable for resawing dry timber, or any kind of square sections, as gang saws are, when several cuts can be made at the same time; but gang sawing, while it is the common method in Europe, as will appear in future illustrations, does not meet present requirements in the United States.

Deals from 9 to 13 inches wide and 3 inches thick can be rapidly sawn, either edgewise or flatwise, by gang saws, but boards or planks from 20 to 30 inches deep, to be sawn with one cut, present quite

another problem. A logical method for such sawing, and one too much neglected, is to spread the pieces behind the saws, and thus give clearance for the saw-dust. This requires strong feeding devices and firm support for the timber in advance of the saws; but these are simple provisions, and not expensive.

Gang saws, while they occupy a prominent place in timber-sawing in the United States, especially in the large merchant mills, have

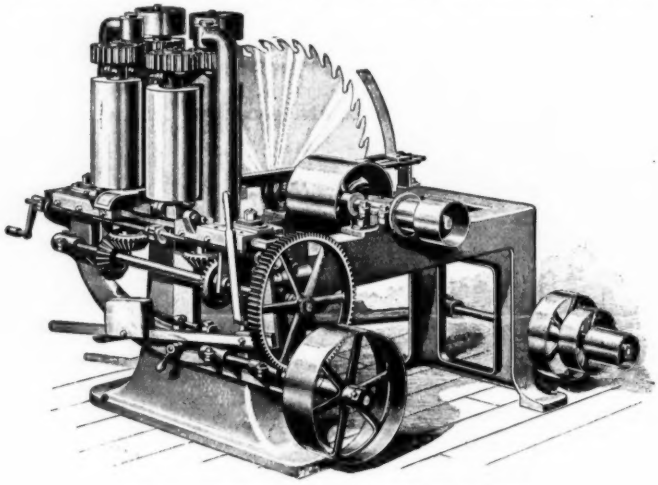


FIG. 15. AMERICAN CIRCULAR RESAWING MACHINE.

Arranged to use either solid or segmental saws. This form has been largely superseded by band resawing machines.

not the important place accorded to them in Europe. Reasons for this are the greater first cost of the machinery and foundation structures; the cheapness of forest timber, which renders kerf waste a less serious matter; and the straightness of the timber, which permits it to be cut on carriages with a straight-line movement. This subject will be further explained presently.

American practice in gang-sawing machines is diversified, the machinery being usually "built in," and made to special plans in each case. There is no "manufacture" of such machines, as there is in Europe, where they are made to regular lists, sent to various parts of the world, and erected on earth foundations.

The illustrations, and the notes accompanying them, will serve to explain common practice, or, at least, will be typical of self-contained machines.

STANDARD SPECIFICATIONS FOR STEEL.

By William R. Webster.

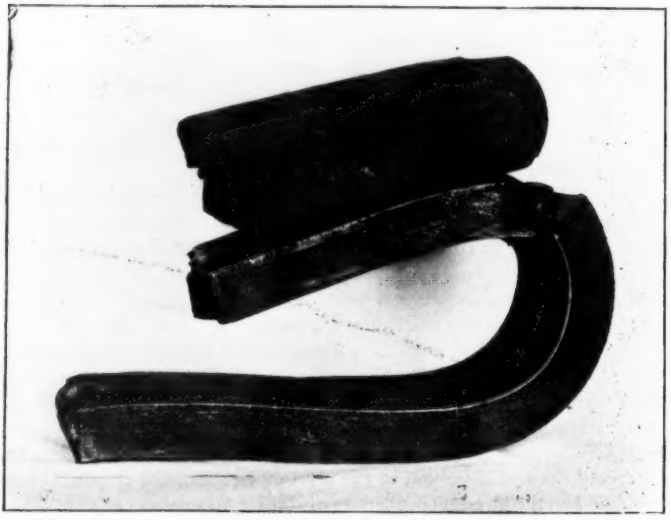
IN the United States the gradual change from the use of iron to steel has been brought about without serious trouble. It was accelerated by the government engineers in taking a firm stand, from the very first, that the requirements of their specifications, both as to quality of material and workmanship, should be lived up to in every particular, and by the same insistence on the part of some of the leading civil engineers. This compelled the steel makers to pay the closest attention to every detail of the manufacture, and, in order to meet the new conditions and not injure the metal, it became necessary for the shops to put in new machinery,—for instance, plate-planing machines, radial drills, reamers, etc.

It was soon shown that the quality of the finished steel did not depend alone on its chemical composition, but that the amount of work it received in rolling or forging, and the finishing temperature, were also of vital importance. Although this has been known in a general way for years, we are still learning, year by year, better to distinguish the effects due to each, and are getting to-day results that were formerly considered impossible. I refer to the method in use at some American mills, where they roll the steel into plates, shapes, etc., meeting all the requirements of the most rigid specifications without making any preliminary tension tests. This great advance has been brought about by the closest observation of the methods of manufacture, and the establishment of the relation between the chemical composition and the physical properties of steel. They proceed as follows:

An analysis of each heat or cast is made while the ingots are still in the soaking pits; from this analysis the ultimate strength is estimated; and, without allowing the steel to cool from its original casting temperature, it is rolled on orders where, as shown by the estimated ultimate strength, it will apply, due allowance being made, of course, for the thickness of the finished product.

This does not in any way relieve the mills from the usual tension tests required of the finished material; but it is of the greatest assistance, both to the manufacturer and the inspector, in checking the uniformity of the steel; as, when heats of steel of about the same chemical composition do not give, approximately, the same physical results, the indications strongly point to irregularities in working, and show where to locate the trouble.

I have made a special point of the heat treatment of steel in connection with work, as it has so great an effect on the structure and quality of the finished material, and as steel of the very best chemical composition can be made brittle and unfit for use (in that condition) by being finished at too high temperature. This trouble increases with the increase of carbon, and also with the increase in thickness of the finished material, and is more likely to occur where heavy sections are rolled on a light mill. When very heavy plates are to be used, it is advisable to anneal them, and take no chances of brittleness caused by too high finishing temperature. By annealing I do not



COLD BEND AND QUENCH BEND OF 3-INCH X ⅝-INCH STEEL TEST PIECE.
These are the tests referred to by Mr. Wille in his remarks quoted on page 949.

mean the slow cooling from the finishing temperature; I mean that the plates should be allowed to cool in the ordinary manner, and then be heated to the proper temperature for annealing.

In this connection I quote the following from my remarks on specifications before the Franklin Institute (November, 1898), and remarks by Mr. H. V. Wille, in the discussion of same, with the photograph of the bending tests referred to:

Too much importance is paid to the quench bends. In some cases the cold bends have been entirely omitted, the quench bends substituted, and considered a reliable test as showing the quality of the material. Now, this is all wrong, as soft steel which has been finished at too high temperature, and thus rendered brittle so that it will not stand the ordinary cold bends, may be restored by the heating, and, the car-

bon being so low that the subsequent quenching does not harden this class of material, it then bends 180° flat on itself without cracking. Material accepted under these conditions has failed under subsequent shop work : but it would have been rejected at the mills, had the ordinary cold bends been made.

Mr. Wille's remarks were as follows :

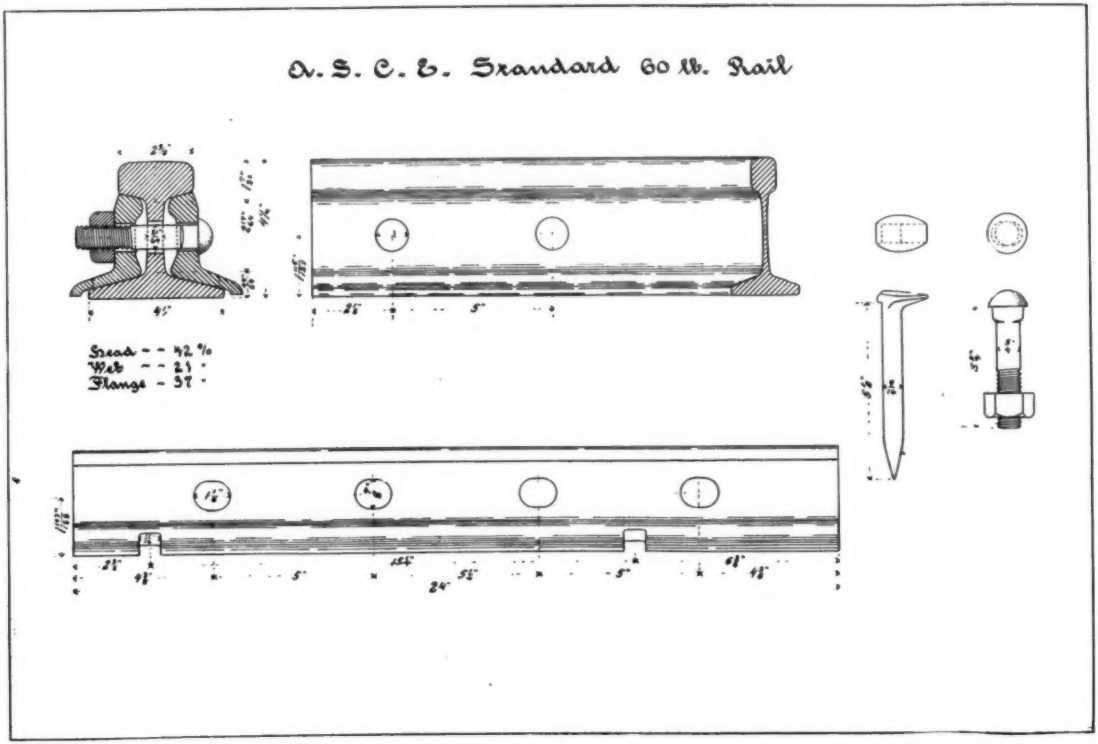
I cannot too strongly endorse Mr. Webster's remarks on the heat treatment of steel, especially those in reference to quench and ordinary bending test. A sample of steel recently came under my observation which, when judged by the tensile strength, reduction of area, elongation, and chemical analysis, would be regarded as the highest grade of material, and, in fact, it passed two inspections on such tests. Notwithstanding the results of these tests, the plate cracked in numerous places, at the holes, when an effort was made to roll to a 60-inch ring. A test was now cut from the plate, and failed, as you will see by this sample, on ordinary cold bend ; but a second test cut from the same portion of the plate, when heated to dull cherry and quenched in water, bent flat without signs of distress, proving that a good plate of steel was injured by finishing at an improper temperature. The quality of the steel can be judged by the following tests :

Tensile strength, lbs. per sq. in.	59,200
Elongation % 8″ section	28.
Reduction of area, %	60.2
Carbon	.24%
Manganese	.39%
Phosphorus	.012%
Sulphur	.020%
Silicon	.020%
Copper	trace.

To-day we are hearing less of the mysterious failures of steel than ever before, as, when a failure occurs, examination nearly always shows that the cause was improper heat treatment or bad shop practice, and not chemically-poor steel. To prove this, good steel has been taken, with which similar failures have been produced at will by the same treatment.

When basic open-hearth steel was first made in the United States, stock high in phosphorus was used ; but it was soon found that this did not give a uniform steel. A stock much lower in phosphorus is now used, and the resulting steel is uniform and in every respect satisfactory. It is used in bridges and all other classes of work on an equality with acid open-hearth steel, and it will equally meet any tests met by the latter. The worst that can be said against basic open-hearth steel, as now made, is its name, as it is often confused with the basic bessemer steel, or basic open-hearth steel made from stock high in phosphorus.

In basic bessemer steel and basic open-hearth steel made from stock high in phosphorus, there is danger of rephosphorization of the steel from the highly-phosphoric slag. This danger is eliminated in the basic open-hearth, when a stock low in phosphorus is



AMERICAN SOCIETY OF CIVIL ENGINEERS' STANDARD 60-LB. STEEL RAIL.

used. Another important fact to be considered in this connection is that, when stock high in phosphorus is used in making basic open-hearth steel, the carbon is burned out before the phosphorus, and the metal, being left unprotected, is easily oxidized. This oxidation is not removed by the subsequent addition of manganese, and we sometimes have irregular and brittle steel from this cause. When a stock low in phosphorus is used in this process, the phosphorus is removed before the carbon, and the steel, being protected by the carbon, is not liable to be oxidized. This shows clearly the causes of the great superiority of the basic open-hearth steel as now made in the United States.

Mr. C. E. Strohmeyer fully appreciates the good qualities of basic open-hearth steel when made from stock low in phosphorus. In a recent paper, read before the Institution of Engineers and Shipbuilders, Glasgow, he explained in detail the properties of this metal, which he calls "Basic Refined Steel." I quote the following:

> My opportunities to study what I ventured to call basic refined steel, and comparing it with acid steel, have been exceptionally favorable and extensive, both in English, German, Belgian, and Austrian works, and I believe that this experience may help to familiarize the members of this Institution with a material which has proved itself equal, if not superior, to steel made in this country. Although it is produced in a basic furnace, I do not wish to class it with the two other basic qualities which are made, respectively, in a Thomas (basic) converter or in a basic open hearth, because these two qualities have not earned for themselves in this country a good reputation in ship-building yards and boiler shops. In fact, the word "basic," when applied to steel, is to many ears but another word for "rotten." To tell shipbuilders in this country that German ships and boilers are almost exclusively built of "basic" steel awakens their curiosity, but to volunteer the further information that failures with such plates are rare is to court being regarded as a romancer. Although the details of the manufacture of acid steel are sufficiently well-known in this district, it will be necessary to refer to them occasionally; and, as there are three basic processes, and not merely two, as is generally supposed, they will have to be discussed somewhat in detail.

Mr. Strohmeyer then fully explains the differences and details in the manufacture of the three kinds of basic steel, and gives the results of a large series of tension and bending tests, etc. After comparing the results, he closes the article with the following statement:

> These results confirm the opinion which is universally held on the continent,—that the two steels, although they both go by the name of "basic," cannot, as is done in this country, be classed together. It has been my endeavor to make this clear, and, if possible, to pave the way for the introduction of what I have ventured to call basic refined steel,—a material which seems to surpass that produced in the acid open-hearth, and which may, perhaps, be the stepping-stone to higher limits of tenacity, and further reductions of scantlings.

All that has been said by Mr. Strohmeyer in favor of the use of basic refined steel, as made on the continent, equally applies to the

basic open-hearth steel as made in the United States, and confirms the good opinion that the government engineers and leading civil engineers of the United States have of this material.

Most of the American specifications are very satisfactory both to manufacturers and consumers; they do not impose too rigorous requirements on the steelmakers or the shops doing the work, yet, if properly enforced, they are sufficient to insure good material and workmanship.

In my own work as consulting and inspecting engineer, I have found requirements in specifications for material on export orders that were so entirely different, in minor details, from the usual practice in the United States as to cause considerable trouble and annoyance, as well as delay; and, on visiting the works abroad, I was surprised at the ease with which many of these requirements were met. Take, for instance, the drilling of oval holes in the web of rails. In this and similar cases the American manufacturers simply did not know how to accomplish the results in the easiest manner; but I am glad to state that, in all the essential matters, they gave the same or equivalent results, and I feel assured that, had orders subject to standard American specifications been placed with foreign manufacturers, they would have experienced similar trouble. This is owing to the different methods in use in the various countries, both in the manufacture of materials and the methods of testing.

The ordinary methods of making and preparing tests should be reduced to a standard. Take, for instance, tension tests. The pulling speed should be specified, and the relation between the width of test-pieces and thicknesses of material should be fixed. About three widths would be sufficient to cover all ordinary thicknesses, and they could be prepared without any increased cost. We also need some simple machine for making impact tests, as the ordinary tension and bending tests do not show all the properties of the material as regards resistance to shock.

Some years ago having been called upon to inspect rails and accessories to be made in the United States subject to foreign specifications, I found it necessary to remodel the specifications in order to comply with American practice, and at the same time retain the essential features of the original specifications. The following specification is one which I prepared under these conditions (for 60-pound rails and accessories) at the request of the engineer of a large foreign railroad, who adopted them after thoroughly investigating the practice and methods of manufacture in the United States, fully appreciating that his former specifications would cause trouble in minor points, which could be covered by equivalent requirements not in conflict

with American methods of manufacture and testing. They have also been adopted by several other foreign railroads, and thousands of tons of rails and accessories manufactured under them have given perfect satisfaction in use.

STANDARD SPECIFICATIONS FOR 60-POUND BESSEMER STEEL RAILS, AND ACCESSORIES.

All of the materials are to be manufactured in the best possible manner, and in accordance with the requirements of this specification.

Chemistry.—Clause No. 1. The steel to contain .35 per cent. to .45 per cent. Carbon, aiming at .40 per cent. Manganese not over .90 per cent., Phosphorus not over .10 per cent., and Sulphur not over .06 per cent.

Section.—Clause No. 2. The section of rail rolled to conform as accurately as possible to the attached drawing, a template of which to be furnished by the manufacturer. A variation in height of $\frac{1}{64}$ of an inch under and $\frac{1}{32}$ of an inch over will be permitted. The fit of the angle fish plate shall be maintained perfect.

Weight.—Clause No. 3. The weight of rails to be kept as near to 60 pounds per yard as practicable, after complying with Clause No. 2. A variation of 1 per cent. in individual rails, and ½ of 1 per cent. in the entire order, will be allowed. At least one rail per hour shall be weighed during rolling, to prevent greater variation than that specified.

Tests.—Clause No. 4. One drop test will be made on a piece of rail not over 6 feet long from each blow of steel, with drop weighing 2,000 pounds, having a striking face with a radius of not over 5 inches, falling 16 feet, on rail placed, head up, on solid supports 3 feet apart. If any rail breaks under this test, two more tests will be made of other rails from same blow, and, if either of these tests fails, all the rails of this blow will be rejected.

Lengths.—Clause No. 5. The standard length of rails to be 30 feet. Shorter lengths up to 10 per cent. of the order, if made, will be accepted in lengths of 28 feet, 26 feet, 24 feet, 21 feet, and 18 feet. But the three shorter lengths must be supplied as follows:

Not less than per cent. of 24 feet,
" " " per cent. of 21 feet,
" " " per cent. of 18 feet.

The usual variation of ¼ inch above or below the specified lengths will be allowed.

When rails are ordered of special lengths slightly shorter than 30 feet, for curves, in order to readily distinguish these rails, the ends are to be painted with white lead, and they are to be taken with the 30-foot lengths in the above schedule.

Drilling.—Clause No. 6. Circular holes 1 inch in diameter to be accurately drilled in accordance with the accompanying drawing. The burrs caused by drilling to be carefully removed.

Finish.—Clause No. 7. The ends of rails to be cut perfectly square; the burrs caused by sawing carefully removed by chipping and filing. The rails must be free from all mechanical defects and flaws; and shall be straight both in surface and line. In the process of straightening, no blows must be used; the rails are to be straightened by gradual pressure, and the gag to have sufficient bearing surface so as not to indent the rails.

Branding.—Clause No. 8. The name or initial of manufacturer, the year and month of rolling, the Railway Co.'s symbol ( ), to be rolled

on the web of the rail, and the blow number to be stamped on the web of each rail.

Inspection.—Clause No. 9. The inspector shall be notified in advance of the time of rolling any part of the order, shall have free access to the works at all times during the manufacture, and have all reasonable facilities afforded, to satisfy him that the materials are being manufactured in accordance with these specifications. The manufacturer shall defray the expense of all tests made at his works to determine the uniform quality of the steel used; and shall furnish the inspector, daily, with the carbon determinations of each blow of steel used, and a complete chemical analysis, every twelve hours, giving the average of the other elements contained in the steel.

Conditions of Rolling.—Clause No. 10. The entire process of manufacture and testing to be in accordance with the best standard practice of to-day. special care being given to the following: Ingots to be kept in a vertical position in the soaking pits, no bled ingots to be used, sufficient discard from the top of the ingots to insure sound rails, uniform temperature of heating, and *uniform finishing temperature in rolling.*

Lighter or Heavier Rails.—Clause No. 11. If rails of lighter or heavier weight than 60 pounds per yard are rolled subject to these specifications, the necessary change in chemical composition and drop tests will be decided by the consulting engineer.

STEEL ANGLE FISH PLATES.

Chemistry Tests.—Clause No. 12. The material to be bessemer steel containing not over .15 per cent. Carbon, .10 per cent. Phosphorus, or .06 per cent. Sulphur, with an ultimate strength of not over 64,000 pounds per square inch; and 25 per cent. elongation in 8 inches. The full-sized fish plate to bend flat cold, without showing any signs of cracks on the outside of bend.

Length, Section, Fit, Weight, Punching, Notching.—Clause No. 13. The angle fish plates to be 24 inches long and rolled to a template representing the accompanying drawing; they shall be perfectly straight and free from all surface defects, ends square and free from burrs, and shall have a perfect fit to the rail for which they are intended. In order to check this, two pieces of rails, properly drilled, must be furnished from each rolling; and a complete splice made. The weight to be within 2 per cent. of that specified. The oval bolt holes to be accurately punched from the rail side of the fish plate outward, in order that the taper of the punched hole may correspond with the taper under the head of bolt, and spike notches punched in flange with well-defined fillets in corners. This work to be done in such a manner as not to distort or injure the bars. The dimensions and position of holes and notches to be exactly as shown in drawing.

Branding.—Clause No. 14. The initials of the manufacturer and year of rolling to be rolled on the bars.

Analyses, Testing.—Clause No. 15. The manufacturer to furnish the inspector with full chemical analyses of the steel used, and the inspector will make sufficient tension and bending tests to satisfy himself that the material is in accordance with these specifications.

Oiling.—Clause No. 16. The finished angle fish plates to be dipped in boiled linseed oil and securely wired in bundles.

BOLTS.

Chemistry, Tests.—Clause No. 17. To be manufactured of bessemer steel, containing not over .10 per cent. Carbon, .10 per cent. Phosphorus, or .06 per cent. Sulphur, with an ultimate strength of not over 64,000 pounds per square inch, and 25 per cent. elongation in 8 inches. The bars to bend flat cold.

Dimensions.—Clause No. 18. The bolts to conform in all respects to the dimensions

shown in the accompanying drawing. The heads to be forged from the solid, free from fins or defects, and the bearing faces of the head and nut to be square with the axis of the bolt.

Threads.—Clause No. 19 The threads to be United States or Whitworth standards, cleanly and accurately cut, so that any nut will fit any bolt in such manner that it can be screwed on by hand to to three-fourths of the thickness of nut, and then fit so tightly that they cannot be moved without the use of a spanner.

Oiling.—Clause No. 20. The finished bolts and nuts are to be heated and dipped in boiled linseed oil, and packed in strong six-hooped kegs of 150 pounds' capacity.

Iron Bolts.—Clause No. 21. If iron bolts are used, the material must be tough and fibrous, having an ultimate strength of 50,000 pounds per square inch, 15 per cent. elongation in 8 inches, and bend cold 180° over once the thickness of the bar. All other conditions to be the same as for steel.

SPIKES.

Chemistry, Tests.—Clause No. 22. To be manufactured of bessemer steel, containing not over .10 per cent. Carbon, .10 per cent. Phosphorus, or .06 per cent. Sulphur, with an ultimate strength of not over 64,000 pounds per square inch, and 25 per cent. elongation in 8 inches. The bars or finished spikes to bend flat cold, without showing any cracks on the outside of bend.

Dimensions.—Clause No. 23. The spikes to conform in all respects to the dimensions shown in the accompanying drawing; to be straight, clean, and free from defects. The heads must be forged from the solid, and underside of heads to correspond with the bevel of flange of rail, and must be capable of being straightened out flat, under the hammer, both before or after the neck has been ground half through.

Oiling.—Clause No. 24. The finished spikes are to be heated and dipped in boiled linseed oil, and packed in strong six-hooped kegs of 150 pounds' capacity.

Iron Spikes.—Clause No. 25. If iron spikes are used, the material must be tough and fibrous, having an ultimate strength of 50,000 pounds per square inch, 15 per cent. elongation in 8 inches, and the bar or finished spike to bend cold 180° over once the thickness of the bar. The heads to be flattened out under the hammer, and the results such as to show that the material has not been injured in forging. All other conditions to be the same as for steel.

After taking into consideration the large daily output of modern mills, these specifications were drawn up in accordance with my system of inspection, and they aim to control the quality of the steel used, without delaying the mills with unnecessary requirements. The drop test from each blow of steel (which represents the shock the rails must resist in service), in connection with the chemical composition, checks the uniformity of the steel, and prevents inferior material from being accepted.

The limit of not more than .10 per cent. phosphorus in my specification is the standard requirement of leading American railroads and engineers. The railmakers are accustomed to it, and fully understand that, when the phosphorus approaches this limit, the other elements must be kept within well-defined limits, in order to produce the best results. This is done, and rails are made meeting all the requirements of drop tests, and all the conditions of service on railroads in the United States and in other countries.

A few American rail specifications call for a phosphorus limit of not more than .06 per cent.; but this is generally considered an expensive luxury, as no basic bessemer steel rails are made in the country, and it is very doubtful if rails low in phosphorus have all the additional advantages claimed.

In some European specifications for rails the same requirement of not more than .06 per cent. phosphorus appears; but this is not at all difficult to comply with where basic bessemer steel is made, or in the few localities having ores low in phosphorus. But, notwithstanding all this, there seems to be a decided difference of opinion as to the phosphorus limit and other chemical requirements. No less an authority than Mr. C. P. Sandberg said at the Stockholm meeting of the Iron and Steel Institute, in 1898:

> The railway congress in Paris, in 1889, demanded rather hard steel rail, but the congress in London, in 1895, would not sanction it. I trust that at the coming congress in Paris, in 1900, engineers will leave out the chemical composition in their specifications altogether, and only demand an adequate tup test for safety, as well as a limited deflection to secure the required hardness, leaving out the tensile tests altogether. These latter are entirely out of place for rails, which are subjected in use to blow or impact; besides, tensile tests are both slow and costly for the preparation of test pieces.
>
> The rail is subject to a blow in practice, and therefore should be tested with a blow. The tup test could be done with one rail end for each cast, and the maximum deflection to specify for each rail section could be obtained by experience in testing rails of the required hardness in each rail section to serve for a hardness as well as a safety test. This system of combined testing would cost next to nothing, and would not delay the inspection of the rails.

There are many reasons why the chemical requirements should not be abandoned in rail specifications. They compel the steelmaker to pay the closest attention to his methods of manufacture, and the resultant steel is more uniform than it otherwise would be.

What is needed is more light on the effect of the different chemical elements on the finished rails. At the present time there are wide differences of opinion on this subject, but I am firmly convinced that, in the end, the general decision will favor steel of fixed chemical composition for the different weights of rails that, in connection with the proper finishing temperature, will make the toughest, safest, and best-wearing rails.

Enough has been written to call attention, in a general way, to the differences between the specifications and methods of testing in the United States and other countries. This is the strongest plea for coöperation with the International Association for the Testing of Materials; and engineers and manufacturers should give freely all the information they have to enable the association to complete its international specifications.

MACHINE-TOOL DEPRECIATION AS AN ELEMENT OF MANUFACTURING COST.

By H. M. Norris.

MY preceding paper concluded with a discussion of the general principles underlying a correct estimation of the original value and subsequent depreciation of foundry patterns. Let us now consider some of the essentials of the following classifications of capital.

"Standard machinery and tools," is intended to include only such plant as may be regarded as possessing universal value,—*i. e.*, machinery of a customary kind, which, though subject to improvement, is of use in so many kindred trades that it retains a fair value till worn out, even if sold under the hammer to other users.

The deterioration of machinery of this class depends upon many circumstances, chief among which are quality and mode of using. Mr. Warner states in his letter that "low-grade tools are in a sad state of dissolution before completion," and that "it is often most profitable to condemn them before starting." Some young, struggling concern, attempting to do business with insufficient capital, may be forced to purchase tools which will shortly have to be replaced by something better, but the installation of low grade tools by such firms as have the necessary funds to procure the best the market affords immediately marks them penny-wise and pound-foolish. The efficiency of the operator cannot disguise the ultimate expensiveness of a poorly-designed and badly-put-together machine. Its best place is the scrap-heap or some one else's shop. On the other hand, a high-grade tool treated with proper care will retain its usefulness a long time, as demonstrated in the second letter of the previous issue. It is obvious, therefore, that, in order to estimate correctly the alterations in value which machinery of this class undergoes from year to year, it is necessary to keep three main factors in view: (1) original cost; (2) probable working life; (3) ultimate selling value.

The "original cost" of a machine must not be confounded with its original value. The former means cost of purchase only, while the latter includes the additional expense of installation. At which of these figures should a machine be inventoried? Mr. Lewis, apropos of a lathe purchased and charged to plant, answers the question thus:

In the first instance, the lathe would be ordered in the ordinary way by a supplier's order and debited to stores account. A works order would be issued for a new lathe, as an addition to plant. The lathe would be drawn out of stores, say to

works order number P. A. 3,217, to which all labor and material absorbed in its erection would be charged. When completed, the prime cost book will show the cost of the whole,—*viz.*, lathe, labor, and material. The establishment charge percentage is then added to prime cost, and the total abstracted to the plant ledger account.

"If the machines are appropriate for their purpose," says Mr. Matheson, "then their value will be arrived at by adding to their original cost the expense of installation, and deducting an amount for depreciation proportioned to their age and wear, and a further amount for any actual repairs they may require."

Are these premises correct? It is my opinion that they are not, except in so far as they apply to a valuation made on account of a change of ownership. They certainly should not be permitted to effect a scheme of depreciation for wear and tear. Expenditures for freight, hauling, and setting up in place ready for running, undoubtedly represent a part of the cost of a new machine; but, since all outlays of this nature are irrecoverable, they should not be given a place on the inventory. The foundation of a machine, and the cost of erecting its countershaft, are of no value to a second purchaser. In fact, the owner is put to the additional expense of taking down the countershaft at the time of sale. If we follow the opposite course, however, and charge the cost of installation to general expense, as practised by some firms, how shall we account to our stockholders for the full amount of their investment? We cannot inventory our expenses, nor can we say (to quote from one of Mr. Oberlin Smith's arguments against the too rapid depreciation of machinery): "Gentlemen, our assets last week, when you paid in your money, were $100,000, but they are now only $50,000, as much of this plant could not be sold, for other purposes than those intended, for nearly the sum which we yesterday paid." To what, then, shall we charge this outlay? Mr. Smith says:

> The grand principle which lies at the root of correct valuation, and which should govern the appraiser throughout all his work, is that any article is worth, not what it *did cost*, but *what it would cost to replace it to-day*, providing it is so useful that it would be desirable to so replace it, were it destroyed. Thus, if a shop has a lot of machine tools which are built so near to the best modern practice that it would be desirable to duplicate them were they destroyed, they are worth exactly what said duplicates would now cost, delivered and set up in the shop, less the depreciation due to the wear and tear.

This is unquestionably a good rule to observe when adjudging the value of a machine as delivered to the purchaser, but does it apply to its value "delivered and set up in the shop"? To make an inventory is to prepare a schedule of assets, and assets are property in possession,—*i. e.*, property that is convertible into money or has a cash value. Value has many significations. Thus, there is the value

to the owner of a plant taken by compulsory purchase; there is the value to partners of a shop in full operation; the value to a purchaser of a factory as a going concern; the rateable value; the value of a plant, as a whole, that has stopped working; the value of a plant that is dismantled and sold separately; and the value obtainable by forced sale. The value with which we are dealing, however, is the sum a thing will bring, if sold to close out business or to give place to new plant. It is the number of dollars a thing will sell for in the market. The outlay incident to the setting-up of a machine is lost the moment it is moved from its original position, and can in no wise be regarded as convertible property. In point of fact, it is not property at all, any more than the cost of advertising is property. Both are necessary to the starting and running of a business, but neither has a marketable value. They must, however, be accounted for to the stockholders. The original cost of a machine is gradually made good by allowance for depreciation, which system *may* be applied to the cost of installation; but a little study will show that this course is not advisable, since we want the depreciated value in the books at time of inventory to represent assets, and cost of installation is not an asset, but a liability to the stockholders. Hence the cost of installation should be charged to preliminary expenses, and be written off independent of the machines proper, leaving only the purchase price as a basis of calculation.

The probable working life of a machine varies in every trade, and for every class of machine. Care in management, hours of actual work, and severity of working all contribute to its deterioration. Protection from dirt, and the use of good oil, sometimes render one machine twice as durable as another. In some shops overtime is the constant practice, and a corresponding shortening of life ensues. A machine has a certain margin of strength, beyond which it cannot be forced without great detriment. Mr. Matheson says:

> Where the production is stimulated by a system of piece-work, the deterioration of the plant is likely to be more rapid than in a factory where the workmen are paid according to time only. In very busy times, when there is a very pressing demand for the products, and profits are large, it may be expedient and remunerative to work long hours, and to force the plant and machinery to their utmost power, even at the risk of a breakdown, so as to take full advantage of the transient high prices; but in such a case a corresponding rate would have to be written off for depreciation.

The ultimate selling value is the value a machine will have when discarded by its present owners, either on account of wear, or in order to make room for a more modern tool; at its minimum, it is equal merely to the scrap-value, or the price of old material, less the expense of removal and breaking-up. It is not, therefore, the original cost which must be provided for in deciding upon a appropriate

rate of depreciation, but that cost less an amount equal to the value of the material prepared for re-use. The contingency of existing plant becoming obsolete must also be considered. Mr. Matheson says:

> There is a wide range within which values may alter, but a proper estimate may be approached, and the issues narrowed, by regarding first the extreme limits of value. For instance, the highest value of any machine will be the cost of a similar machine, ready for immediate use, together with the expenses of installation. If invention and skill have been bestowed on any additions, a higher value may have been reached than is represented by the original cost and the subsequent outlay, and notwithstanding that the machine is partly worn. The best proof of efficiency in a machine may be afforded by actual working. . . . The lowest extreme is represented by the scrap value, or the price which may be depended on for the old material. The relation which this lowest value bears to the original cost obviously depends on the proportionate value of the materials and that of the labor that has been bestowed upon them. Articles of copper and brass may have a scrap value approaching nearly to the price when new. So also may articles of cheaper materials, if of a simple kind. Thus, old rails, or railway chairs, may be worth as scrap iron half their original value. On the other hand, the scrap value of light and intricate machinery may be a mere fraction of the original cost. Again, the value of old material is sometimes greatly reduced by the cost of preparing it for re-use; such is the case with the removal and breaking up of cumbrous and heavy iron work.

Deterioration takes place much more rapidly in some classes of machinery than in others. Boilers require a higher rate of depreciation than engines, and engines a higher rate than machine tools, but, whatever the rate, it should be estimated liberally for the first few years, when revision will show whether it needs alteration. Generally speaking, machine tools depreciate in ten years to something less than half of their original cost, however thorough the up-keep. If a well-made milling machine cost $650, it would be prudent to write off 8 per cent. the first year, and afterwards at the same rate annually from the diminishing value, this, in most cases, being sufficient, if all repairs and renewals are paid for out of revenue. In three years its book-value would stand at $506, and in six years at $395. If repairs amounting to $50 are then found necessary, this amount may be added to the capital value, the depreciation rate of 8 per cent. continuing for three years longer, till the value is reduced to $386, when, in all probability, it will be expedient to replace it with a more modern machine. The reason for the small decrease in the last three years appears in Fig. 1.

The capital value of a machine should be increased by only two kinds of expenditures,—*viz.*, the renewal of worn-out parts, and the enlarging or strengthening of the tool as a whole, so as to increase its earning capacity or selling value. Both of these outlays may be regarded as helping to neutralize its depreciation, but they should be applied with great discretion. The soundest way is to charge all repairs and renewals to general expense, but this precaution is unnec-

STANDARD PLANT LEDGER

MACHINE ... NO. 3 PLAIN MILLER

MAKER CIN. MILLING MACHINE CO. COST: $ 650

LOCATION : FLOOR 2 ROW 2 NO. 8

PURCHASED 1-6-99 | ESTIMATED LIFE 15 YRS.

NEW OR S.H. NEW | PROB SELLING VALUE: $ 185

WEIGHT 3400 POUNDS | REQ'D. RATE OF DEP'N. 8 %

91	598	96	395								
92	550	97	413								
93	506	98	420								
94	466	99	386								
95	429										

LOSSES, REPAIRS OR ADDITIONS TENDING TO NEUTRALIZE OR AUGMENT DEPRECIATION

DESCRIPTION	ORDER	DATE			CREDIT		DEBIT	
GENERAL OVERHAULING	8624	12	15	96	50	00		
RACK ATTACHMENT	SOLD	3	6	97			40	00
" "	2742	8	14	"	80	00		

FOR COST OF INSTALLATION AND LIST OF ATTACHMENTS SEE REVERSE SIDE

FIG. 1. THE "COST OF INSTALLATION AND LIST OF ATTACHMENTS" WILL BE FOUND ON PAGE 967.

essary where the charges are allocated with due regard to their value to the machine.

Calculations of depreciation by the system of writing off a given percentage annually may be greatly facilitated by the use of Table 1, which is taken, in part, from Mr. Matheson's book, and shows the effect of different rates of depreciation for any term up to thirty years. Suppose we want to find the depreciated value in 15 years, at the rate of 5 per cent. per annum, of a machine whose original cost was $1,200. Referring to the 5-per-cent. column, we find .463,291 as the depreciated value of 1 after 15 years, and this multiplied by 1,200 is $555.95, or the depreciated value sought. Again, what will be the value in 25 years of a $6,000 building, if written off at the rate of 2 per cent. per annum? Looking in the table opposite 25 and under 2 per cent., we read .603,466, which multiplied by 6,000 is $3,620.80.

The table is of great assistance in deciding upon a rate of depreciation which, in a given term of years, will provide for the estimated loss. It does not, however, show what generally takes place as regards renewals and additions, which may more than neutralize the depreciation. It is necessary, therefore, to keep an accurate and intelligent record, not only of the original cost, but of all subsequent repairs and additions, as well as of the rate at which each has been written off. This may be very satisfactorily accomplished by means of a plant inventory book, in which entries are made of each machine, together with its belongings and cost of installation, the number of each page corresponding with the number of the machine recorded thereon. A convenient form of ruling for this purpose is shown in Fig. 1. Such a book, if properly kept up, will enable the manager to make such readjustment in rate of depreciation as he may find expedient from time to time. It provides not only for the recording of such outlays for repairs and additions as tend to neutralize depreciation, but for a full and comprehensive history of the capital investment made on every machine in the plant, together with a list of attachments included in the inventory valuation of each. The listing of attachments and loose parts is very important, as all losses must either be made good out of revenue or be subtracted from the value of the machine to which they belonged. The sample page illustrates the mode of writing-off the $650 milling machine already described.

Loose plant, such as drills, reamers, taps, cutters, etc., is not treated in the above matter, which applies to fixed plant only. Small tools give out so rapidly, and require so frequent renewal, that writing off a percentage annually is not a satisfactory method of dealing with them. It would necessitate a rate of about 50 per cent. To treat

TABLE I.*—THE EFFECTS OF DEPRECIATION AT DIFFERENT RATES FOR TERMS OF YEARS.

YEARS.	1%	2%	3%	4%	5%	6%	7%	8%	10%	12%	15%	20%
1	.990,000	.980,000	.970,000	.960,000	.950,000	.940,000	.930,000	.920,000	.900,000	.880,000	.850,000	.800,000
2	.980,100	.960,400	.940,900	.921,600	.902,500	.883,600	.864,900	.846,400	.810,000	.774,400	.722,500	.640,000
3	.970,299	.941,192	.912,673	.884,736	.857,375	.830,584	.804,357	.778,688	.729,000	.681,472	.614,125	.512,000
4	.960,596	.922,368	.885,292	.849,346	.814,506	.780,749	.748,052	.716,392	.656,100	.599,695	.522,006	.409,600
5	.950 990	.903,921	.858,734	.815,372	.773,781	.733,904	.695,688	.659,081	.590,490	.527,731	.443,705	.327,680
6	.941,480	.885,843	.832,972	.782.757	.735,092	.689,870	.646,990	.606,355	.531,441	.464,404	.377,149	.262,144
7	.932,066	.868,126	.807,982	.751,477	.698,337	.648,478	.601,700	.557,846	.478,297	.408,675	.320,577	.209,715
8	.922,745	.850,763	.783,743	.721,389	.663,420	.609,569	.559,581	.513,218	.430,467	.359,634	.272,490	.167,772
9	.913,517	.833,748	.760,231	.692,534	.630,249	.572,995	.520,411	.472,161	.387,420	.316,478	.231,617	.134,218
10	.904,382	.817,073	.737,424	.664,832	.598,737	.538,616	.483,982	.434,388	.348,678	.278,500	.196,874	.107,372
11	.895,338	.800,732	.715,301	.638,239	.568,800	.506,299	.450,103	.399,637	.313,811	.245,080	.167,343	.085,899
12	.886,385	.784,717	.693,842	.612,709	.540,360	.475,921	.418,596	.367,666	.282,429	.215,671	.142,232	.068,720
13	.877,522	.769,023	.673,026	.588,201	.513,342	.447,366	.389,294	.338,253	.254,186	.189,790	.120,905	.054,976
14	.868,746	.753,643	.652,836	.564,673	.487,675	.420,524	.362,043	.311,192	.228,768	.167,015	.102,770	.043,981
15	.860,059	.738,570	.633,250	.542,086	.463,291	.395,292	.336,700	.286,297	.205,891	.146,973	.087,354	.035,184
16	.851.458	.723,798	.614,253	.520,402	.440,127	.371,575	.313,131	.263,393	.185,302	.129,336	.074,251	.028,148
17	.842,943	.709,323	.595,825	.499,586	.418,200	.349,281	.291,212	.242,322	.166 772	.113,816	.063,113	.022,518
18	.834,514	.695,136	.577,950	.479,603	.397,214	.328,324	.270,827	.222,936	.150,095	.100,158	.053,646	.018,014
19	.826,169	.681,233	.560,612	.460,419	.377,354	.308,624	.251,869	.205,101	.135,085	.088,139	.045,599	.014,412
20	.817,907	.667,609	.543,794	.442,002	.358,486	.290,107	.234,238	.188,693	.121,577	.077,562	.038,760	.011,529
21	.809,728	.654,257	.527,300	.424,322	.340,562	.272,701	.217,842	.173 597	.109,419	.068,255	.032,946	.009,223
22	.801,631	.641,171	.511,655	.407,349	.323,533	.256,358	.202,593	.159,709	.098,477	.060,064	.028,004	.007,379
23	.793,615	.628,348	.496,306	.391,055	.307,357	.240,958	.188,411	.146,933	.088,629	.052,856	.023,803	.005,903
24	.785,678	.615,781	.481,416	.375,413	.291,989	.226,501	.175,222	.135,178	.079,766	.046,513	.020,233	.004,722
25	.777,822	.603,466	.466,974	.360,396	.277,390	.212,911	.162,957	.124,364	.071,790	.040,921	.017,198	.003,778
26	.770,043	.591,396	.452,965	.345,980	.263,520	.200,136	.151,550	.114,415	.064,611	.036,010	.014,618	.003,022
27	.762,343	.579,568	.439,376	.332,141	.250,344	.188,128	.140,941	.105,261	.058,150	.027,289	.012,425	.002,418
28	.754,720	.567,977	.426,194	.318,855	.237,827	.176,840	.131,075	.096,840	.052,335	.024,014	.010,562	.001,934
29	.747,172	.556,618	.413,408	.306,101	.225,935	.166,230	.121.900	.089,093	.047,101	.021,132	.008,977	.001,547
30	.739,701	.545,485	.401,006	.293,857	.214,639	.156,256	.110,076	.081,966	.042,391	.018,596	.007,631	.001,238

* For the convenience of readers of THE ENGINEERING MAGAZINE who may desire to keep this table for reference, a reprint of it has been made, upon single sheets, which will be furnished, free of charge, upon application.

them as current expense is much better practice, although some firms prefer to value such articles afresh every year. Others, after a fair valuation has once been fixed, write nothing off thereafter, but maintain and renew out of revenue, which is equivalent to regarding them as consumable stores. A third plan, and one which seems to have met with considerable favor, is to value everything of this kind, whether old or new, at half its original cost. It is doubtful if one plan is much better than another. They are all bad. And it is a question whether it is worth while to attempt more than an approximate determination of their value, which, at best, is all that we could hope to make without the expenditure of immense labor.

"Special tools, jigs, and fixtures," item D, should be classed in a category by themselves, as they are rarely salable as second hand plant, except in so far as they have a scrap-value, or are sold with the business as a whole. The phrase "special tools, jigs, and fixtures," as here used, does not mean such appurtenances as are made on a customer's order for some special work, but special tools devised for the cheapening of standard articles of manufacture. The former have no book value whatever, and should, in consequence, be charged as expense to the particular work for which they were designed. The latter, however, are quite as much a part of capital as any other kind of plant, and should so appear on the books of the company until superseded by more improved devices, or until the work for which they were made is altered or its manufacture discontinued in whole or part.

With some firms this item of asset is comparatively insignificant; with others it is paramount. Special machinery is the most expensive kind of plant, costing usually several times as much as standard plant; and where it constitutes a firm's chief equipment, as is not infrequently the case, it must of necessity be treated as capital.

The true value of special plant may be said to be represented by the value of such ordinary plant as it replaces, plus whatever saving in wages and general expense is effected through its use. Considerations of this nature should not, however, be permitted to enter into an appraisement made for the purpose of establishing a book value, which obviously should be taken at actual cost in all cases where the plant is appropriate to the work for which it was intended. In other words, it should be taken at the valuation of the cheapest plant procurable that will do the work with equal facility. Mr. Smith says*:

> The depreciation of special tools for wear and tear need be but very little, as, if they serve their purpose at all, they must be kept in such repair as to serve it perfectly; and they are not a marketable article in which a slight deterioration in appearance would largely affect their value, as it would be the case with standard articles. . . .

* "Inventory Valuation of Machinery Plant." Trans. A. S. M. E., Vol. VII., p. 433.

The rules governing an appraiser may be tersely stated thus: rate all property that it would be desirable to reproduce, were it destroyed to-day, at the net cost of such reproduction, in its existing locality, minus its estimated damage by wear and tear. Rate partially obsolete articles the same way, but minus also a percentage of their apparent value equal to their estimated percentage of obsoleteness or of improbability of usefulness Rate wholly obsolete articles at nothing.

He says further; in a later paper, on the "Intrinsic Value of Special Tools":

Concerning this subject, there are two principal schools of belief, with a practice, in individual cases, ranging all the way between the extreme views held on either side. The first of these views is that a special tool should not be reckoned as partly obsolete while in the full career of its usefulness, but that very careful watch should be kept for any indications of a lessening demand for the merchandise which the tool is made to produce. The moment such indications appear, depreciation should commence, and should be made rapid enough to be surely on the safe side, and to bring the value of the tool down to nothing but what it is worth for old material, before said marketable demand has entirely ceased. . . . The opposite view regarding valuation of special tools, and one which is held by many shrewd and careful manufacturers, is that they should be depreciated by a large percentage every year, until their value stands *nil* upon the inventory. One popular belief is that a special tool hasn't any value at all until it has paid for itself in extra profits. Carrying this latter principle to a logical conclusion, it should be rated first at nothing, and gradually *appreciated* up to full price. All of this is, of course, working upon the safe side, as regards the danger of over-valuation, but it is difficult to see how a corporation, for instance, could account to its stockholders for the money which they paid in, if all the plant happened to be of this special nature. An inventory upon such a basis would also be rather an awkward document to show to would-be purchasers of the business who were to be assured of its prosperity.

In practical dealings with this question, it seems to me that the best course is to give all special tools an inventory rating at their apparent value, and then to lay aside a portion of the extra profits which these tools have earned by their special usefulness, in the general reserve fund, or "Surplus," of the concern. They may thus be drawn upon, should any too sudden collapse in values take place.

In view of the large number of manufacturers making daily use of special tools, and the importance of the question of their value to most of them, one cannot feel other than surprised that there should be so great a diversity of opinion as to the manner of their treatment at the time of inventory. The conditions governing their valuation are as obvious as those which apply to standard plant, and, in most cases, they can be much more easily appraised. Both are measured in the same currency, the only difference being that the one should be taken at its commercial, or marketable, value, while the other must be reckoned on the basis of its value to the owner. Let us examine the question in detail.

I had occasion recently to design a set of tools for the lathe work on one of our radial drill columns. The outfit cost $172.80, and reduced the time eight hours. Machines of this size are selling at the rate of one hundred per year. Taking the workman's wages at

25 cents an hour, and general expense at 20 cents an hour, the saving per year aggregates $360.00. Now, what are these tools worth? To an outsider, nothing; to us, assuming that the present value of a special tool depends upon its earning possibilities, the particular equipment cited should be valued at $360 — $172.80 = $187.20, the first year, $360.00 the next, and the same figure thenceforward, provided the sales remain the same year after year, the matter of deterioration not being of sufficient moment to require consideration. But on this basis increased sales run the value of the tools to an extravagant figure; even on the present business it is beyond their original cost, which, of course, is debarred—the valuation being limited by the cost of making. They are certainly worth $172.80. To charge this amount to general expense would make it appear as a liability,—something that should be paid for immediately, as are consumable stores,—which it positively is not; yet we dare not charge it to standard plant, as we have no assurance of the length of time during which the tools will continue in use, and we know that they are valueless as second-hand plant. What, then, is to be done? There appears to be but one solution. They must be classed in a category by themselves, the value of which will represent assets—or nothing, according to the object of the inventory, which may be to determine their value either to the owner, or to a prospective buyer of the business, or to learn the amount by which the whole assets of the company must be decreased in a winding-up of the business.

The next question to be considered is the matter of their depreciation. This depends solely upon the extent of obsoleteness. They are worth their cost so long as the saving which will be effected through their *future* use is not less than that cost. That is to say, the tools will continue to be worth $172.80 until such time as they will be used but $172.80 — $(8 \times .45) = 48$ times more. Granting that this logic is correct, we then have the following general rule, which, though perhaps especially applicable to jigs and fixtures, is, I think, sufficiently elastic to cover special plant of all kind:

Charge all non-perishable tools of an unusual and irregular nature to special plant at cost. Let their value remain at this figure until the saving in cost on the future probable output of said tools falls below their cost. Then depreciate, dollar for dollar, in accordance with the shrinkage that occurs from time to time in the total amount of saving that will be effected during the remaining term of their usefulness.

It now remains to consider only how, after the tools have been once appraised, they may be satisfactorily treated in the books of the company. Inventory-taking is, at best, a jading and perplexing

SPECIAL-PLANT LEDGER

TOOLS FOR _No 1 Radial Drill_ SYMBOL _6A_

MARK	MADE	COST	TOTAL	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899
6A 1		25											
" 2		15		5									
" 3		30	70										
" 4	2 4 90	48 50											
" 5	4 6 "	6 75											
" 6	7 15 "	10 25	65 50		10 25								
" 7	1 3 91	8											
" 8	3 7 "	5 50			1 50								
" 9	5 9 "	10 25	23 75										
VALUATION IN JANUARY				70 00	130 50	142 50							
SHRINKAGE DURING YEAR				5 00	11 75								
VALUATION IN DECEMBER				65 00	118 75								

FIG. 2.

problem, and it is safe to affirm that, unless it can be shown that the labor incident to the successful working of a proposed system alleviates, to a greater or less extent, the irksomeness attending the prevailing practices, that system is very sure to be rejected.

In Fig. 2 is shown the method and style of book employed by the writer. In this ledger is kept an accurate record of all tools possessing more than a scrap-value, all of which are grouped with due regard to the kind and size of machine in the manufacture of which each is to be used. On old tools, of uncertain history, only the column headed "Cost" is filled in, while all new tools are entered in full, examples of both being shown in the illustration. The figures under "1890," and opposite "Valuation in January," show the inventory value in January, 1890, of all tools in use on the particular machine to which this page of the ledger is devoted. If, during that year, tool 6 A 2 is depreciated $5, this amount is entered under "1890" and opposite "6 A 2." At the end of the year this sum is subtracted from the January value of $70, leaving a remainder of $65. It will be seen, however, that three new tools (6 A 4, 6 A 5, and 6 A 6) have been added during the year, aggregating $65.50 in value, which, when added to the depreciated value of $65, for the old tools, gives $130.50 as the total valuation of all the tools at the commencement of 1891. In this year, tool 6 A 6 is written off entirely, and tool 6 A 8 depreciated $1.50, giving $118.75 plus $23.75, or $142.50, as the value of all tools in January, 1892. The book thus accomplishes nine distinct objects. It shows: (1) just what tools have been made for each machine; (2) the date when each was made; (3) what each cost; (4) the total valuation of the tools added each year; (5) the amounts by which each has been depreciated; (6) the year in which said depreciation was made; (7) the amount by which the full set has been depreciated; (8) the total valuation of all tools at the beginning of any year; (9) the total valuation of all tools at the close of any year.

Instead of having to go over, and revalue, from one to two thousand special tools every year, it is necessary only to note what tools have been rendered obsolete since the last inventory, the entries being made by the chief draughtsman at the time of making the alterations in the corresponding drawings and patterns which destroyed their usefulness. The prime cost book shows pretty closely what the tools are saving. Catastrophes, causing the demand for a standard machine to suddenly cease, are rare. Hence it is not difficult to determine the time when the future saving likely to be effected by an outfit of tools falls below their rated value. And, with this danger line clearly before him, there is little excuse for the manager who passes it.

THE FIELD FOR THE AUTOMATIC GAS METER.

By Edward A. Harman.

AS one of the minor phases of engineering, the rapid development of the penny-in-the-slot system which has astonished the millions demands something more than a passing notice. One of the adaptations which is most serviceable—and most surprising in its apparent failure as yet to obtain in the United States a foothold at all comparable to that which it it has found in Great Britain —is that for gas distribution. Possibly the enormous success of this system is due mainly to the reasonable desire of the public to know what they are buying, to the cash payment, and to the immense popularity of the pennyworth.

With the slot meter the lessening of the light constitutes a gentle reminder that a definite quantity of gas has been used. Possibly it is the absence of any such check or hint in the case of ordinary consumers that leads to dissatisfaction when the account is presented. In cases where a slot meter has materially increased the consumption, by the facility afforded through the medium of the cooker, there cannot arise any dissatisfaction with the amount. The consumer knows at the time the reason of the increase, whereas, ordinarily, months elapse, and he may be unable to recollect the cases of illness or other exceptional circumstances which caused an increase of consumption.

It has occurred to the writer that an automatic arrangement might be attached to ordinary meters to check the consumption at intervals of 1,000 or 10,000 cubic feet of gas, thus reminding the consumer of his rate of consumption. But in most cases such an arrangement would probably be a nuisance.

To such a state of perfection have automatic gas meters been brought that is is impossible to foresee how far they will be ultimately extended. It is probable that in the near future the managers of different rooms, workshops, offices, etc., in the same institution, will control the consumption of what is required for lighting and heating purposes by automatic interception meters, rather than allow an indefinite quantity of gas to be used, without regard to cost, as the general custom is now. Such waste affects not only the cost of production of materials, but also the health of the workers, which is of the first importance. It may be found advantageous, where rooms are let as apartments in houses or hotels, to make each tenant responsible

for his own consumption of gas, in preference to the unsatisfactory fixed charges so generally made in England and on the continent. For internal arrangements in workshops slot meters might be employed, by a mutual arrangement with the head of the department and the employees. Of course the meter would be the property of those directly concerned. The meters, being fixed in a passage or landing, could easily be made accessible for examination and for collection at suitable intervals. In cases of illness the ready check afforded upon the consumption of a bedroom stove is a satisfactory feature.

Applications for automatic meters are so numerous that few British gas undertakings can afford to ignore them—especially in view of their effect in increasing consumption of gas. They increase revenues not directly only, but indirectly, by popularizing gas in every home, office, or workshop. It has recently been pointed out that for city and town offices a gas fire is perhaps as advantageous a method of heating as can be used, no attention being required from the time the stove is lighted in the morning until the gas is turned off at night, except to raise or lower the flame in accordance with the demand for heat. For bedrooms, gas fires are growing in popularity. Where connected directly with the chimney by a flue, this method of heating is peculiarly suitable. The temperature of a room can be maintained evenly night and day, which in case of illness is of great importance, while the dirt, bustle, and disturbance of the patient involved in making a fire are dispensed with. Moreover, heat is always available,—an advantage which those affected with asthmatical, bronchial, or kindred complaints cannot afford to disregard, in view of the liability to sudden attack in the middle of the night, when hours must elapse before a coal fire can be made.

Many gas undertakings are now recognising the importance of supplying apparatus for gas fires, fitting free of cost, and making only a nominal annual charge for the stove. The undertaking of which the writer is the engineer is doing this with good results. In consequence of what has come to be known as the "Fixed Free" stove business, numerous stove and meter makers have been inundated with orders, the delays thus occasioned being vexing alike to the consumer and the gas officials. The method of calculating the desirability of adopting the penny-in-the-slot system is simple. The writer's experience is that, for an ordinary automatic meter for lighting purposes only, the annual gas-consumption is 10,000 cubic feet; where a small cooker is supplied, the consumption is doubled. This quantity of gas, at the profit on cost of manufacture, will furnish an income equal to interest on the small original outlay, depreciation, and extra cost of col-

lection. From twenty to thirty-five cubic feet of gas for a penny is the general charge. In the United States, where gas at one dollar per 1,000 cubic feet is considered cheap and lower rates are not often afforded to the consumer, even in large cities, the price will probably seem very small. On the side of the gas undertaking, however, is the certainty and simplicity of collection and the dispensing with all the office labour connected with recording meter readings, keeping a multitude of small individual accounts, and dealing with a multitude of small complaints.

An ordinary flat-flame burner consuming five feet per hour will last from four to seven hours on the expenditure of a penny; where an incandescent burner is used, consuming from three to four cubic feet per hour, the pennyworth will last proportionately longer. Generally speaking, gas undertakings in Great Britain supply fittings, burners, meter, and stove free of cost, so that the consumer's maximum liability is only one penny. The addition of a small cooking stove is as great a convenience comparatively in small class property as in large, where gas cooking-stoves are considered well-nigh indispensable.

A development which has been so productive of satisfaction to the gas undertakings and to the consumer, so far as it has been followed, deserves the attention and study of engineers and managers, with a view to extending its benefits where it is known, and establishing it in places where, although an innovation, its introduction seems likely to be attended by similar success.

A REVIEW OF THE NICARAGUA CANAL SCHEME.

By W. Henry Hunter.

THE project for the construction of a maritime canal on the Nicaraguan line resembles its rival of Panama, in that it is the modern outcome of a lengthened history.

The years 1850–52 form an important landmark in the narrative, for in those years, and at the instance of the Transit Company (in whose hands the whole of the trans-isthmian trade—such as it was—then lay), Col. O. M. Childs, a canal engineer of special ability and experience, made the first engineering survey of the Nicaragua route ever executed, which, although necessarily meagre and incomplete, has formed the basis of all which has since been done in connection with that route.*

Col. Childs submitted a report and a proposal for a waterway with a ruling depth of seventeen feet, which appears, so far as it went, to have been of a workmanlike character, and suitable for the requirements of fifty years ago, the weakness in the scheme being due to the inefficient design of the harbour at Brito, which formed the Pacific terminus of the undertaking. This weakness was, in some degree, recognised by Childs himself, who, with refreshing *naiveté*, deprecated criticism of the design, on the ground that he was a canal engineer, and inexperienced in the construction of harbours. A much more serious weakness, then latent, since developed, lay in the decaying condition of the Atlantic terminus, the harbour at Greytown, which, in Childs's time, was still commodious and convenient, but in which, since his time, deterioration has ended in destruction.

The year 1872 furnished the next stage in the story, when the United States government despatched a party under the charge of Commander Lull, U. S. N., to examine further the route proposed by Col. Childs, and to obtain, in addition, such information, topographical, physical, etc., as was practicable in the time at the disposal of the expedition. Commander Lull presented his report in December, 1873. He recommended that the Childs project be en-

* The Editors hoped to present, with this paper, a series of illustrations which should show the progress of work on the Nicaragua canal as accurately as the progress of the Panama enterprise was exhibited, by photo-engravings, last month.

Two fatal obstacles were interposed. First, the actual work done, as summed up by Mr. Hunter on the opposite page, is too small to supply many subjects for illustration of canal construction; second, the Maritime Canal Company decline to supply any photographs except for use in connection with an article which has their approval. Mr. Hunter's view point, being the same as that of the Ludlow commission, is not pleasing to them. The photographs presented show the general topography of the country traversed.

larged, that the ruling depth of the canal be increased to twenty-six feet, that the locks be made longer and wider, and that certain modifications be made in the positions of the locks and dams.

Among the gentlemen who formed the Lull expedition was Mr. A. G. Menocal, who had just entered the government service as a civil engineer attached to the United States navy. Under the direction of the government Mr. Menocal revisited Nicaragua in 1880, and again in 1885, carrying out at each visit further geodetical operations and reporting to the government in 1885. Mr. Menocal suggested important modifications in the Childs project as amended by Lull, which, with others introduced from time to time since the date of the report, are practically all embodied in the scheme now presented by the Nicaragua Canal Company; it is, therefore, unnecessary to describe or discuss them at this point.

Shortly after the publication of Mr. Menocal's report, and through his agency, a concession was obtained from the government of Nicaragua for the construction of a canal within the Nicaraguan territory, and on the line proposed by Mr. Menocal. The concession provided, *inter alia*, that the final plans of the canal should be deposited, and that the work should be begun in earnest, within a period of two and one-half years from the date of signature. The Nicaragua Canal Construction Company therefore was formed, the concession was transferred to it, some money was raised, and arrangements were made for the commencement of preliminary operations at the terminus of the canal on the Atlantic seaboard.

In 1889 the Maritime Canal Company was formed under a special charter from the United States legislature, and the concession was transferred once more,—this time from the Construction Company to the Maritime Company, arrangements being made, somewhat difficult for outsiders to follow, by which the work was still proceeded with by the Construction Company. That the arrangements were not without their advantages became apparent in 1893, for in that year the Construction Company went into liquidation, leaving the position of the Maritime Company intact.

Since 1893 the financial situation has, in the words of the present president of the Construction Company, "been bad." It has been difficult to obtain money, and but little work has been executed. Prior to that date, a length of one thousand feet of pier-work had been constructed at Greytown, a channel had been dredged on the foreshore, and some three-quarters of a mile of the canal had been formed by dredging in the low, swampy ground. A single line of railway had also been formed across the lagoon, from Greytown to the site of the first lock, the length of the line being about eleven and one-half

miles. These works, with the addition of certain telegraph lines, represent the sum total of the efforts which have been made to construct a waterway on the Nicaraguan line.

The project which the Construction Company thus commenced to carry out was one which was described in a report by Mr. Menocal, and which was submitted to the company in 1890. The report was adopted, and the project accepted by the company as its own.

Before describing the project in any detail, another important event in the history of the scheme should be noted. In 1895, following upon the passage through the legislature of an act to amend the Maritime Company's act of 1889, and under special statutory powers, a board of engineers was appointed by President Cleveland "for the purpose of ascertaining the feasibility, permanence, and cost of construction and completion of the Nicaragua Canal," as proposed by the company. The board was composed of three members, each of whom was a distinguished engineer of special experience and of absolute impartiality, the names of the members being Col. Ludlow, U. S. A., Mr. Endicott, U. S. N., and Mr. Noble, a civil engineer specially experienced in canal construction.

These gentlemen spent six months in a careful study of the Canal Company's project, going over the route in Nicaragua and examining the drawings and documents in New York. They presented their report on October 31, 1895. The report was not regarded by the Canal Company as a satisfactory document, and, since its publication, the representatives of the company have met the conclusions arrived at and the recommendations made by criticisms couched in terms of such asperity as almost to border upon acrimony.

Notwithstanding these efforts (natural enough under the circumstances) to weaken the force of the report, it still remains the one authoritative pronouncement by an impartial tribunal upon the proposal of the Nicaragua Canal Company, or, to speak more accurately, it did remain as such until a very recent period, when the second commission appointed by the United States government, and presided over by Admiral Walker, presented a report which, from the abstract presented, seems to emphasize the value of the opinions expressed by Col. Ludlow* and his associates.

In the following effort to describe the Nicaragua Canal project as developed by the company, the views and recommendations of the Ludlow board will, so far as is practicable, be considered together with the details of the company's scheme.

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*The place occupied by Col. (now General) Ludlow in the confidence and esteem of his fellow-citizens may be gathered from the fact that he has recently been appointed to fill the difficult and responsible post of governor of Havana.

The termini of the proposed waterway have been located, respectively, at San Juan del Norte, or Greytown, as it is more commonly called, on the Atlantic, and at Brito on the Pacific. A line joining these two points would lie but a few points off due east and west, the distance between them being about 140 miles as the crow flies. The same distance measured on the line of the waterway is given by the Canal Company as 169.4 miles, but even this elementary figure has been adversely criticised by the board, which considers it to be 4.5 miles too short, in which case the total length is about 174 miles.

PRIMITIVE NAVIGATION ON CENTRAL AMERICAN WATERS.

The special feature of the Nicaragua route is the great inland sea which lies in the hollow between the eastern and western Cordilleras, and which is known as Lake Nicaragua. It has a length of 110 miles, an average width of 40 miles, and an area of about 2,600 square miles, the mean level of the surface being 110 feet above the sea. This great lake divides the projected waterway into three sections, as follows:

1 From Greytown to the easterly side of the lake, 100.40 miles.
2. Across the lake, 56.50 "
3. From the easterly side of the lake to Brito, 17.25 "

The special feature of the company's scheme for the waterway,

THE HARBOR AT PORT LIMON.

and that which differentiates it from its predecessors on the same line, is the proposal for the extension of the summit level—the level of Lake Nicaragua—both to the eastward and to the westward by the formation of two huge dams,—on the one hand, at Ochoa on the Rio San Juan, at a site below the confluence of the San Juan with its greatest tributary,—the San Carlos, and, on the other hand, at La Flor, in the basin of a small stream called the Rio Tola. The summit level would be so extended through the construction of these dams as to cover a length of about 149 miles out of the total length of 174 miles, —that is to say, a vessel passing through the Nicaragua Canal would traverse a section of nearly 150 miles in length without any lock.

Taking Greytown on the Caribbean sea as the starting-point of a description of the details of the company's scheme, the most formidable difficulty which lies in the way of the achievement and of the successful working of the project is met with at the very threshold. Greytown lies in a re-entrant angle formed by the delta of the San Juan, and on a lagoon which was once a harbour, the mouths of the river which form the present channels of discharge for its waters lying to the eastward and southward of the lagoon.

VOLCANO OF MONOTOMBO, NEAR LAKE MANAGUA, NICARAGUA.

The reason for what, in the language of theology, would be termed the perversion of the harbour has been the subject of much discussion, although the leading physical features to which the perversion has been due, and as to which all are agreed, are fairly well defined. First, the San Juan drains an area of more than 15,600 square miles. The rainfall in the watershed is enormous, the maximum being on the Atlantic coast line, where it reaches the prodigious figure of three hundred inches per annum! From that coast-line the rainfall diminishes sensibly in the direction of the Pacific, but is still extraordinarily great over the whole watershed. Then the basin of which Lake Nicaragua is the centre, and to which the San Juan furnishes the outlet, has been subjected for unknown ages to volcanic disturbance, and is still dotted over with cones and craters. This volcanic activity (now well-nigh outworn) furnished an unlimited supply of material for transport to the sea, while the rushing rivers, themselves the products of the torrential rainfall, furnished the transporting power required.

The swamps on the fringe of the Caribbean, through which the mouths of the San Juan have been formed, bear witness to the potency of these mighty volcanic and climatic forces, for, through their effects, the coast line has been thrust back from the low hills, whose feet were once laved by the ebbing and flowing tides, but which are now divided from the ocean by some ten or twelve miles of intervening land, swampy land, formed of the *débris* from the hills and the upland vallies, and from the igneous dust emitted by the sobbing craters and brought down by the burdened streams.

The distance between the hills and the coast line would have been greater than it is, but, as the river thrust the delta further and

further into the sea, the coast winds, constantly varying in force, but within certain limits nearly steady in direction, have acted, and still do act, on the coast line, striking it at an angle, causing ceaseless wave action and consequent attrition, and re-disposing the eroded material along the coast in a more regular and even way than that in which it was first deposited.

As a result of all this, there is a constant trend of material towards the re-entrance angle in which Greytown is situated, with the further result that the one-time safe and commodious harbour was first shoaled and then obliterated, the fact being that the angle is being filled up, slowly, but surely.

The policy which fights against the forces of nature is a mistaken one; it is foredoomed to failure. Nature may be aided in her operations; her more gigantic forces may to some extent be curbed and controlled; but an almost certain Nemesis pursues any effort which may be made to arrest and to determine in an absolute way a process so continuous as that of the filling up of the Greytown bight.

Having in view the facts of the case as to Greytown, and having, after close investigation, arrived at the conclusion that the destruction of the harbour there *was* due to a continued effort of nature, the board recommended that the efforts which had been made to commence the construction of the canal at that point should be abandoned, and that the entrance should be moved some distance to the eastward. The recommendation has been met on the part of the representatives of the Canal Company by stout resistance, their principal objection being that the change would involve the transfer of the terminus from the territory of Nicaragua to that of the neighboring State of Costa Rica, and that the transfer would not be agreeable to the Nicaraguan government and might imperil the concession.

The word "government" is of elastic significance. It has one meaning when used in relation to a civilized and powerful State, and quite another when used in relation to an Isthmian republic.

Difficulties raised by a government of this class should not be insuperable, nor can objections based on the apprehension of such difficulties be regarded as weighty. Nevertheless the difficulties are maintained by the Canal Company; they decline to abandon their infant works at Greytown, and adhere to that point as the terminus of their scheme. No person who has had practical acquaintance with the difficulty of keeping open a navigable channel across a sandy foreshore will doubt that, if a channel of the required depth can ever be formed at Greytown, such channel would be filled up whenever strong winds from the east or northeast might prevail for any time, and silted up to such an extent as to effectively block the traffic (except

perhaps in the case of small vessels of light draught) for weeks together, even in the face of the most desperate efforts, which would undoubtedly be put forth for its removal by a frantic administration.

A CENTRAL AMERICAN FOREST.

From Greytown the course of the canal will pass through low, swampy lands and stagnant lagoons, till the rising ground which is to form the site of the first lock is struck. The length, measured on the line of the canal, is already ten miles: it is not anticipated that any constructive difficulties will be encountered in this length. Lock No. 1 is to have a lift of 31 feet from mean sea-level; and, in conjunction with it, a series of small embankments are to be constructed, so as to close the gaps in the hills and form a basin above the lock. Through this basin a channel is to be carried to the second lock, the work required being merely excavation and dredging. Lock No. 2 is to be placed at a distance of 1.25 miles from Lock No. 1, and is to have a lift of 35 feet; a second basin is to be formed above Lock No. 2, with a channel of a length of 1.95 miles to the third lock. A heavy dam and another series of embankments will be required to impound the waters in the second basin. At Lock No. 3 the summit level—provided the anticipation of the promoters be realised—will

be attained by a lift of 40 feet. It is necessary to insert the proviso, as a serious discrepancy exists between the anticipations of the advisers of the company and those of the board. Further reference will be made to this discrepancy. It is sufficient here to say that, in the view of the board, the lift at Lock No. 3 will be 44 feet.

A third basin is to be formed above Lock No. 3 by means of a third series of embankments. Through this basin the navigation will be carried for about three miles, where the spur of the Cordilleras, which forms the "eastern divide"—that between the Caribbean and Lake Nicaragua—will be reached. A favourable location for the line of the canal has been found through the spur; yet the cutting required will be of sufficiently formidable dimensions, as the length will be 2.90 miles, the maximum depth 328 feet, and the mean depth 141 feet.

The possibilities of disaster in a cut of these dimensions are almost infinite, and the most searching and complete investigation is required before even an approximate estimate of the cost of carrying it into execution can be made. The board complains that no such investigation has been made, and points out that the borings which the company did make showed "rock more or less decomposed" at great depths below the surface, "which may crush and cause the sounder rock above to fall." This ominous fact appears to have been overlooked or ignored by the company.

It is proposed that the bottom width of the canal in the cutting through the eastern divide should be reduced to 100 feet, the bottom width of the channels at either side being 120 feet. After leaving this cutting, the course of the canal is to be carried through four basins, which are to be formed in the San Francisco and adjoining valleys, and are to be connected by three cuttings of moderate depth, the aggregate length being 3.5 miles. A further series of dams and embankments, some of which will be huge, perilous, and costly work, will be required to enclose these basins.

It is claimed that* "several important advantages are gained by this treatment," the first being an obviously substantial saving in the cost of excavation. The claim proceeds: "The economy, however, is not confined to the saving in excavation, against which, of course, must be charged the cost of the embankments, but is principally in the enormous saving in the deep rock excavation following. and in the valley of the Deseado beyond, by carrying the summit level through into the valley of the stream. The increased cost to result from a plan contemplating a much lower level would have been so

* "The Nicaragua Canal," by A. G. Menocal. Paper read at the World's Water Congress, 1893.

great as to seriously handicap the undertaking financially." It is further claimed that the gain in navigation facilities and in maintenance are important, and that the drainage operations will be assisted by the high-level scheme.

There is a grave doubt as to whether the advantages to be gained by the treatment proposed are commensurate with the almost incalculable cost of the works, the risks of construction, and the uncertainties of maintenance, involved in the formation of dams 80 to 85 feet in height from the level of the ground, upon sites in which the borings revealed that a depth of thirty feet of soft mud must be passed through before anything in the nature of firm soil can be reached, and in a climate in which "rainfalls of nine inches in nine hours, and of three in a single hour," are experienced.

The original intention was to form these dams to such a height as to enable their crests to be employed as waste weirs for drainage purposes. Had this intention been carried into practice, disaster would have been not only courted, but constrained. More prudent counsels have prevailed, however, and the present intention is that the dams

A SAMPLE OF RAILWAY CONSTRUCTION, SAN JOSE.

should be raised above the highest water level, and that the drainage should be provided for by sluices, to be placed in the solid ground, at a low level, and adjacent to the site of each dam.

These sluices, together with other works, have been provided "to meet possible contingencies, specially in the series of embankments in the San Francisco ridge, which, it is frankly admitted, is the weakest feature in the whole route."*

At the westerly extremity of the uppermost of the three cuttings by which the basins in the San Francisco ridge are to be connected, the course of the river San Juan itself will be struck. It is intended that the course of the San Juan should be utilized for navigation for the whole distance between the uppermost cutting and Lake Nicaragua,—a length, according to the company, of 64.5 miles, or, according to the board's correction of the company's figures, 69 miles.

To permit of the utilization, the level of the San Juan, and of its great tributary, the San Carlos (the confluence of the two streams takes place at a point about four miles further up the course of the San Juan), must be raised to the level of Lake Nicaragua. In order to achieve this, the formation of another huge dam is projected, the location being at Ochoa in the San Juan valley. The design for this dam is said to have "been for years the subject of long study and careful consideration." Unfortunately the ground at the site which had been selected is of the most unfavourable character for the foundation of such a work, the central borings having been carried to a depth of twenty-five feet below the bottom of the river, without reaching any material more satisfactory than drift sand. The central borings were abandoned at the depth stated, so that the depth at which a solid foundation might be found is unknown; while the side borings—*i. e.*, those on the flanking hills—showed that thick beds of clay overlay the rock. Owing to the foundation difficulty, all idea of constructing a dam of the solid character usual in cases where consequences so momentous would follow a failure was abandoned, and a proposal which is considered "to embody simplicity, economy, and safety" was adopted. The proposal is to dump "from an aerial suspension conveyor large and small material properly assorted, across the river, from bank to bank, until a barrier is created sufficiently high and strong to arrest the flow and hold the waters at the desired level." It is not intended that the dam should be water-tight, it being assumed that the flow of the San Juan will, in the driest season, be ten times as great as the quantity of water which will be required for lockage and other traffic purposes, and consequently that 90 per cent. of the flow may be permitted to discharge itself *through the dam*. (The board entirely disagrees with the assumption as to the minimum flow of the San Juan.) It is further intended that, in addition to the use of the dam as a filter of a singularly coarse type, the

* Mr. Menocal's paper to the World's Water Congress.

crest thereof should be employed as a waste weir, discharging a considerable proportion of the immense floods of the San Juan.

The principles of static resistance to dynamic stress are now fairly well understood in the engineering world. The application of these principles to the case of the proposed Ochoa dam has, briefly stated, the following results: (1) the frictional resistance to sliding or rolling, one over the other, of the component parts of the dam, is to be destroyed by invited percolation; (2) an impelling force of kinetic energy is to be induced to act upon the dam, in the manner in which that energy will be most effective; (3) an equation of the forces of

A ROAD IN THE CENTRAL AMERICAN CORDILLERAS.

resistance and destruction will be established, which will take the form of a somewhat extended line of *débris* over a considerable part of the valley of the San Juan. It is hardly necessary to add that the proposal has provoked almost unanimously adverse criticism, since it was first announced; yet it is gallantly maintained by its author. It is a modern instance of *Athanasius contra mundi*.

The company proposes that the crest of the dam should be formed at a level of 105 feet above the sea. It intends that the summit level of the lake shall be 110 feet, and, as it anticipates that a fall of

three fourths of an inch to the mile will be found to exist, even in dry seasons, over the whole surface of the San Juan for the 64½ miles (as they reckon the distance) which intervene between the lake and the site of the dam, it proposes to provide for the fall of 4 feet and for the overflow depth on the crest by lowering that crest 5 feet, thus arriving at the proposed level of 105 feet.

Herein is the discrepancy between the anticipations of the company and those of the board, to which reference has already been made. The board is of opinion (and most practical men will agree with them) that the dry-weather flow from the lake has been seriously over estimated, and that, in view of the true quantity of water passing and the great sectional area of the canalized river, the surface inclination of the river will be practically *nil*, as the river will become but a prolongation of the lake. This important question sensibly affects the estimates of the cost of construction.

But few words are required to describe the proposed course of the navigation between Ochoa and Lake Nicaragua. The work in rendering the San Juan, as raised and canalized, suitable for navigation purposes being of an ordinary character. No question of en-

A NATIVE HOUSE, COSTA RICA.

VENGANZA BRIDGE, ATLANTIC RAILWAY.

gineering practicability, either as to construction or maintenance, will arise. The questions are only as to cost and time. The company proposes that the bottom width of the channel shall be 125 feet, which appears to be sufficient, except at the curves; the board recommends 250 feet as the width.

The proposal for the formation of the channel across Lake Nicaragua also admits of great brevity of review. On the navigation line the lake measures about 56½ miles from side to side; to form the channel, some 14 miles of dredging through soft mud will be required on the westerly side, while on the easterly shore a rocky ledge of 400 yards in width will be met with, through which the course of the canal is to be carried by means of blasting and dredging. Two short protecting piers are also to be constructed at the easterly junction of canal and lake. The course of the canal will strike the lake at the point where the river San Juan flows out from the lake, and will leave the inland sea at the point of inflow of the river Lajas. The length of that course from the mouth of the Lajas to the Pacific terminus will be a little more than 17 miles; of this length some 9 miles, measured from the mouth of the Lajas, will be in continuous cutting, the "west-

ern divide" being reached at 4.70 miles from the commencement of the cutting. Even through the "divide" the depth of the cutting will be moderate,—73 feet,—the point of intersection being, in the words of the company, "the lowest in the mountain chain which extends from the Arctic ocean to the straits of Magellan." The excavation will be mainly in rock, and it is intended that through the deeper part the bottom width shall be 100 feet, the width on either side being 125 feet. The western extremity of the cutting will debouch upon the valley of the Rio Grande, which, with the adjoining valley of the Tola, is to be converted into a huge basin by another great dam, to be formed at a place known as La Flor, where the fourth and fifth locks are also to be built. La Flor is about fourteen miles from the western shore of Lake Nicaragua, measured (like the other distances referred to in the foregoing) along the course of the canal.

Looked at upon the surface, the site of the proposed dam appears to be most favourable, as the valley is constricted and the flanking hills are high. Unfortunately the difficulty as to foundations, which is inherent to almost the whole of the route proposed for the canal, becomes particularly acute at La Flor. Borings made on the line of the dam showed that no less than 100 feet of very soft material would have to be passed through before the rock could be reached and a foundation obtained. Originally it was proposed that a "rock fill" dam, similar to that suggested for Ochoa, should be dumped in at La Flor, but the design has been modified,—very prudently; and it is now intended that a solid core of concrete, founded upon the rock, shall be formed, and shall be reinforced by earthworks, on either side. Properly proportioned and executed in a workmanlike manner, this would form a satisfactory and reliable dam, and one upon which the safety of a great waterway might be allowed to depend; but it is desirable that the estimate of its cost should be made or revised by some person who has already carried out a similar work, while the manner of construction proposed for it throws the remarkable character of the design for Ochoa into even stronger relief.

Locks 4 and 5 will have a combined fall of 85 feet,—*i. e.*, from the summit level 110 feet to 25 feet above sea-level.

From these locks the course of the canal will traverse the valley of Brito, in which, and at a distance of 1.58 miles from Lock No. 5, Lock No. 6, the last on the route, is to be constructed. As the Pacific has a tidal rise of 8 feet at Brito, the fall at Lock No. 6 will be variable, 29 feet being the greatest fall and 21 feet the least. From this lock to the Pacific foreshore a channel of nearly a mile and a quarter in length will be formed; the work will be confronted by no special difficulties, and calls for no special remark here.

In the paper which was presented to the Chicago Congress of 1893 by the chief engineer to the company—to which reference has already been made—it was stated that "the only well-founded criticism to the Nicaragua route of an inter-oceanic canal is the lack of good harbours." Strict literary accuracy might take exception to the statement, having regard to another statement in the same paper (quoted *in ante*) that "the series of embankments in the San Francisco ridge . . . is *the weakest feature in the whole route*," and might well argue that, if, in the case of the harbours (or want of harbours) where the weakness appears to be regarded as but compar-

A RAILROAD CUT IN EARTH AT LA JUNTA.
Showing the steep earth slopes.

atively great, criticism of the company's project is admitted to be "well founded," criticism of a feature whose weakness is the subject of superlative description may claim to have an even more substantial basis.

Be this as it may, there can be no doubt that the want of terminal harbours is the overwhelming difficulty which would have to be encountered, if a serious effort were made to construct and work the waterway on the Nicaragua line, as now proposed.

Brito is not as bad as Greytown, but Brito is bad enough. There the board found, even in the calmest weather, "a nearly constant

HEAVY GRADE ON THE FERRO CARRIL DE COSTA RICA.
Showing the steep earth banks.

surf, with breakers from 4 to 10 feet and over in height." Storms are said to be rare, which is fortunate, as their effect upon a practically unsheltered coast, with a "fetch" of many thousands of miles behind, must be simply irresistible.

The harbour question may, therefore, be readily epitomized. On the one hand, the terminus at Greytown would always be subject to the risk of obliteration by the Atlantic waves: on the other, the terminus at Brito would ever be liable to destruction from the roll of the Pacific breakers.

The estimate of the cost of construction published by the company is $65,000,000. A board of engineers reviewed these figures on behalf of the company, and increased them to $88,000,000. Including the sum required for payment of interest out of capital during construction, the gross estimate becomes $100,000,000.

The Ludlow board expressed a halting hope that the sum of $133,000,000 might be found sufficient for the actual construction. It is reported that the Walker commission has ventured upon an estimate of $124,000,000 for the same cost.

Festina lente is the classic form of the good old Saxon proverb, "The more haste, the less speed." There are few enterprises to which the proverb does not apply, and none to which its application is of more cogent importance than that for the construction of the inter-oceanic canal. Advancing civilisation, bringing in its train the increasing requirements of a multiplying population, demands that the Central American isthmus should no longer be permitted to act as a barrier to the circulation of trade. The manner of the severance and the route which should be followed are still matters of debate, constituting a question to which no authoritative answer has been given.

The people of the United States form the principal factor upon which the settlement must depend, and it is to the United States, as a nation, that the world must look for the assurance that the settlement is the best possible, and that, when the pronouncement in favour of one route or the other is made, it shall be free from the influence of passion and from the taint of prejudice.

There is but one method by which the people of the United States can discharge this national duty and attain the object which is ad-

SOME OF THE PRODUCTS OF THE COUNTRY.

mittedly to be desired. That is the constitution and appointment of a competent tribunal,—a tribunal composed of men who enjoy the confidence and esteem of all that is best and most worthy in the civilised world, and whose judgment would command general acceptance. Before this tribunal let the advocates of both routes—Panama and Nicaragua—appear by counsel and present their respective schemes, supporting the project by such scientific testimony as they can produce. Let, above all things, the evidence adduced on each side be tested by competent, and therefore searching, cross-examination.* Let the enquiry be of the most public kind ; let all the proceedings take place in the blaze of a light as fierce as that which is said to beat "upon the throne" ; and let the decision be accepted as final by the world.

There is a disposition on the part of certain persons to attempt to rush the Nicaragua Canal project through at the present moment. High ground is being taken by these persons, patriotism is invoked, self-interest is called into play, and other efforts are being made to excite feeling, whether of a worthy or of an unworthy character. The question is too great to be settled in this manner. The American nation is but beginning to take its true place among the families of the earth ; it is like the sun, rising in strength and rejoicing in the race which is set before it, and which it is just commencing to run. Paltriness of object and littleness of vision would stultify the nation at this time ; petty selfishness would blight its growth. This canal question presents an opportunity to the people of the United States in which they can show that they appreciate their great place and their high position, and show it by assisting to settle the question in such a manner as will be for the benefit of humanity and for the advantage of the world. That manner will involve selection of the best possible route and of the best possible proposal,† and under present circumstances no convincing decision can be given in which such selection can be embodied, except by a tribunal of the character above indicated, sitting under circumstances such as we have ventured to recommend. America's true interest would be served by this, and all would agree to entrust the waterway constructed under America's auspices to America's trustee-like custody.

* The necessity for cross-examination will become abundantly clear to any expert who peruses the report of the proceedings when "House Bill 35 (on the Nicaragua Canal)" was before the committee on interstate and foreign commerce of the house of representatives in Washington, in 1896.

† Present reports are that the estimates of individual members of the Walker board vary from $90,000,000 to $140,000,000. Mr. Hunter himself says :

"Having in view the lack of necessary information, and the enormous risk which will attend upon the operations necessary for construction, experience leads to the conclusion that, if any body of undertakers were able to carry through the works and open the canal to the trade of the world at an inclusive cost of $200,000,000, these gentlemen might well congratulate themselves upon their astonishing good fortune."

ELECTRICITY AT THE PARIS EXPOSITION OF 1900.

By Georges Dary.

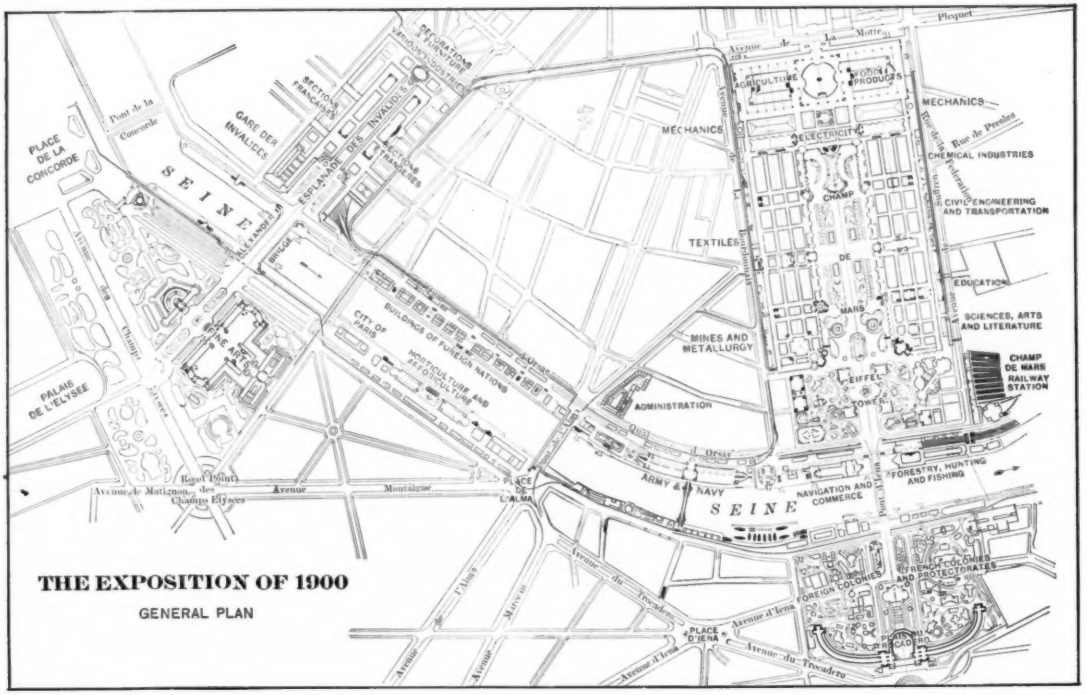
PARIS is everywhere in a state of upheaval—a prey to the fever of work. On every side, digging and building are in progress —embankments arising, trenches and foundation walls extending in regular lines, pillars towering, trusses stretching overhead, and scaffoldings raising their complicated tangle.

By train and by wagon, *débris* and structural materials are borne hither and thither; the noises of saws and hammers, the sharp whistling of cranes and locomotives, the cadenced cry of workmen handling heavy masses, rise in a strange mingling—it is chaos!

And this air of the workshop—of the hive in full activity—extends throughout the Champ de Mars, the Champs Elysées, the banks of the Seine, the Esplanade des Invalides, and the Montparnasse station —along the line of the belt railway, over the Metropolitan—to the Gare des Invalides, to the Gare d'Orléans, the Quai d'Orsay, in fact, everywhere.

For Paris would have everything ready that, fourteen months hence, she may receive worthily her many illustrious guests. In maintenance of her fame as a city of hospitality, she works day and night that she may, in May, 1900, welcome the world to an international reunion expresssive of the productiveness of industry and invention—the seal of the friendship which should lastingly unite the industrial peoples, and the dawn of a new era of peaceful labour.

When we recall the exposition of 1867, and the small space it occupied in the buildings of the Champs Elysées, we can gain an idea of the immense progress made by science and industry since a date so relatively recent even as that. The stages of this progress are clearly defined by the successive enlargements of the Paris expositions of 1878 and 1889. In 1878 the Champ de Mars and the Trocadéro scarcely sufficed; eleven years afterward the Exposition had extended over the left bank of the Seine and begun to encroach upon the Esplanade des Invalides. Still another lapse of eleven years, and that immense area no longer suffices; to the Champ de Mars, the Trocadero, and the Invalides must be added a large part of the Champs Elysées. The old Palais d'Industrie is superannuated; it must be torn down, and in its stead two gigantic buildings erected for 1900—one of them a marvel of architectural taste.



THE EXPOSITION OF 1900

GENERAL PLAN

Further, after having thus invaded the Champs Elysées, the Exposition stretches yet beyond, along both banks of the Seine, which are widened by solid masses of piling, and the narrowed river will flow, in 1900, between two ranks of splendid buildings from the Pont de la Concorde to the Pont Mirabeau, near the fortifications.

The Machinery Hall, with the Eiffel Tower, will be the only vestiges of the Exposition of 1889 remaining in 1900; and even the machinery building will be transformed, since it is designed to shelter

THE CHATEAU D'EAU.

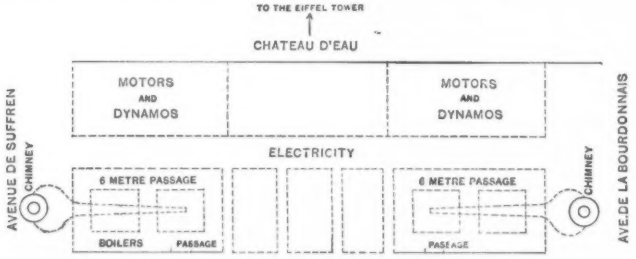
an entertainment hall of 6,300 square metres, capable of containing 25,000 spectators, while its two ends will be devoted to agricultural and food displays.

In the flanking buildings there will be, on the right, on the Avenue de Suffren—Sciences and Arts, Education, Instruction, Civil Engineering, and Transportation (M. Hermant, engineer); on the left, Mines and Metallurgy (M. Varcollier, architect) and Textiles. At the bottom will be the Château d'Eau, and behind it the Electricity building, designed by M. Hénard.

The Electricity Building, with the Château d' Eau and its illuminated cascades, will form the "*clou*"—the "great attraction"—of the Exposition. The cascades will furnish the water for the boilers of the power-plant.

The artistic part of this structure is in the hands of M. Paulin, professor of architecture in the Ecole des Beaux Arts. A great arcade, about thirty metres wide and ten deep, forms the principal "motif" of the structure, which is, in all, 127 metres long. This arcade encloses a great vase, from which the water flows over into basins placed one below the other to form a series of cascades.

From an opening in the centre of the arch, at the level of its springing, an enormous waterfall, 12 metres wide, pours out, 2,000 litres per second being required to supply this singular fountain. A group of statuary, of heroic size, surmounts the arcade, which is further elaborately decorated with sculpture. To the right and left of the two pylons are still other cascades. In the evening this Palace of Neptune will be a veritable fairy-land, all the cascades being illuminated by electric lights in changing colours. Every pinnacle of the



PLAN OF THE ELECTRICITY SECTION.

building, and every line of its architecture, will be picked out in incandescent lamps, the whole effect being continually varied from the controlling switchboards.

The façade of this building, as well as those of the other prominent edifices, will be garnished with panels of translucent enamels of various colors, behind which will be placed incandescent lamps, permitting an endless variety of combinations of lights, forms, and colours. When it is remembered that, in addition to all this display of light, there will be 10,000 powerful incandescent lamps on the Eiffel tower, it may readily be imagined that the evening *fêtes* on the Champ de Mars will be truly brilliant.

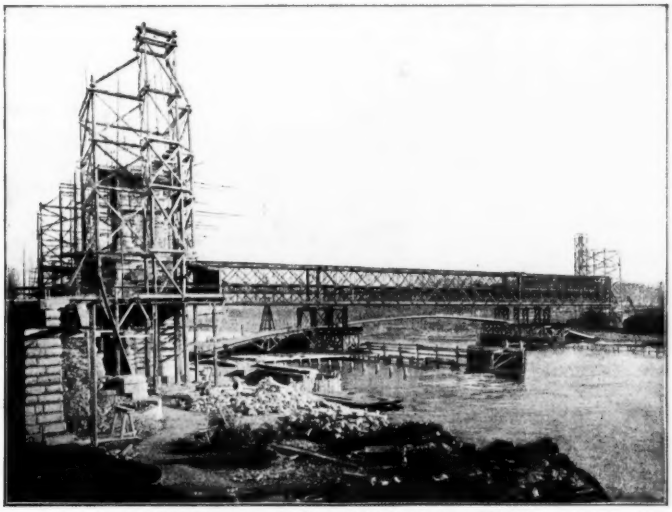
The great façade of the Electricity Building is built partly of metal and partly of glass, with escutcheons of hammered zinc and translucent porcelains. It is immediately behind the Château d'Eau, and will reach a height of 80 metres. The electricity division will be 420 metres long by 80 metres wide, this space including also the mechanical installation in connection with the electrical exhibit.

The arrangement of the exhibits is in three parts,—in the centre a sort of square hall, and two lateral wings. For the construction of these latter the frames of the old 30-metre gallery of the last Exposition were used, with part of the frames of the old 25-metre gallery placed at each side, so as to give the total width of 80 metres, as indicated above. A catastrophe has delayed the construction of this

building. The bold project of M. Hénard, which was to move the entire 30-metre gallery from the place that it occupied formerly, was almost accomplished, when a severe wind-storm utterly wrecked the metallic structure. No one was hurt, but the frames were rendered entirely unserviceable. The Syndicat des Forges de France was immediately set to work upon new frame pieces, and it is thought that there will be no difficulty in completing the Electricity Building in time.

It seems useless to cite a list of the varied applications of electricity which will be grouped in this building. The novelties that this subject has in reserve for visitors to the Exposition will doubtless be marvellous, but the inventors are carefully keeping their secrets, and there has been, as yet, no break in their silence.

The electric current, produced upon the Champ de Mars for feeding the different motors and for the extraordinary lighting effects, will



FALSE-WORK FOR THE ALEXANDER III. BRIDGE.

be generated in two stations. One of them, called "la Bourdonnais," and reserved for French constructors, will be installed in a building 117 by 40 metres in size, between the Central Electricity Building and the Avenue de la Bourdonnais; the other, which will be reserved for the use of foreign constructors, will be similar in size and arrangement, and will be called the Suffren station, being on the side of the grounds toward the street of that name. Each of these two groups of

generating apparatus will form a concession to a single representative, who will negotiate directly with the technical service of the Exposition. The administration will turn over to him the settings for boilers, the necessary foundations, and will construct, at its own expense, the smoke-collectors and chmineys; but the setting and assemblage of the steam-generating apparatus will be at the charge of the constructors.

Water for boiler-feeding and condensation will be furnished gratuitously, and the proprietor of each exhibit will be indemnified for the daily cost to which he is put for the production of steam. In each of the two installations described there will be groups of boilers able to produce, under normal conditions, at least 10,000, and probably, as a maximum, 20,000, kilogrammes of steam per hour. Independent condensers, installed by the technical service, will permit the attachment of all the engines. The water used for this purpose will come from the luminous cascade of the Château d'Eau. The same conditions attach to the electric generating groups. Both are considered as parts of the Exposition, but will be exploited and operated by the special engineering service of the Exposition itself.

The dynamos will be coupled directly, or mounted upon their shafts to the engines. This disposition allows the reduction to the smallest possible limits of the space necessary for the apparatus. Electric current will be delivered upon a switchboard—also a part of the constructors' exhibit—under the following conditions of tension, etc.:

Single-phase current.....2,200 volts, frequency, 50.
3-phase current.....2,200 volts, frequency, 50.
Direct-current, 125, 250, and 500 volts.

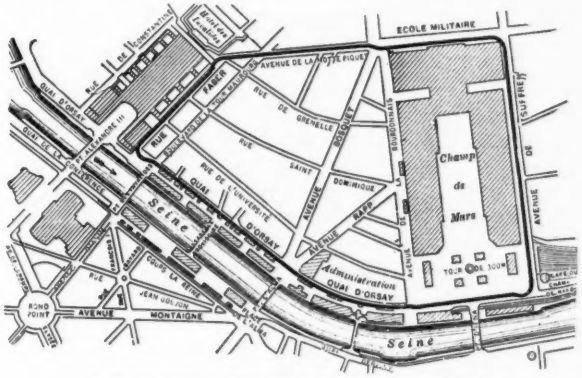
Naturally each of the generating units will be provided with its own switchboard, comprising all the auxiliary apparatus and safety-devices needed for its operation, and for connecting it in service with the others upon the main switchboard.

The boilers installed in the two main steam-generating plants will be set up in a symmetrical fashion. They will be mounted alongside of each other, and will all be of the same type in each group. Through the middle of each building will run two large flues for the reception of the smoke, these being subterranean galleries growing larger as they approach the chimney, into which they are led by curves. (See page 994) The chimneys will be monumental structures,—18 metres in diameter at the base and 4.5 metres at the summit, and having a total height of 80 metres. There will be one at each side of the grounds,—that is to say, at each end of the electrical exhibit.

The technical service of the exhibition is made up of four sec-

tions: first, Mechanical Installations, under the direction of M. Bourdon; second, Electrical Installations, directed by M. Picou; third, Handling and Hoisting Apparatus, of which M. Guyenet is the director; fourth, Hydraulic Installations, under the management of M. Meunier. This committee will have charge of various questions relating to the four divisions mentioned. The electrical committee comprises forty-four members, under the presidency of M. Mascart.

So far as electric lighting is concerned, the fact that the Exposition, like that of 1889, is to remain open in the evening, but in a more complete manner, caused it to be foreseen from the beginning that a minimum power of 20,000 h. p. would be required for the electric lighting. To this figure must be added at least 5,000 h. p., which will be required by power apparatus. The Eiffel tower will be one of the attractive elements of the illuminations at night. Its four cor-

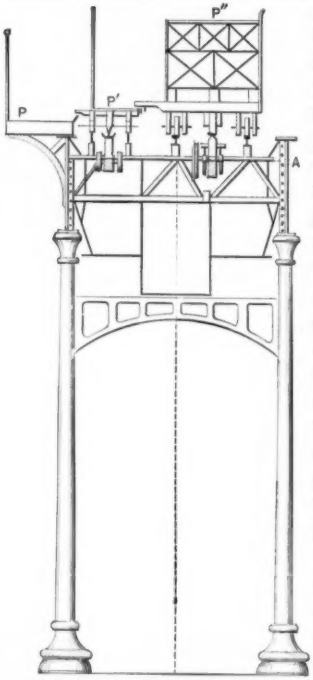


PLAN OF THE ROUTE OF THE MOVING WALK-WAY.

ners and all the principal lines will be dotted with large incandescent lamps, of which more than 10,000, placed one metre apart, will be necessary for its illumination. To render the effect more startling, its illumination may be accomplished instantaneously by the working of a series of switches, operated by a single key situated at a distance; the object of this being that distinguished personages may, by a simple touch, illuminate the tower, whose luminous silhouette will be visible within a radius of 40 kilometres around Paris. The lighting of the big wheel, similar to that shown at the Chicago Exposition, in 1893, must not be forgotten. This is in place, and is already ornamented with about 1,000 incandescent lamps. The electric lighting is not confined at all to the Champ de Mars; it will extend to both banks of the Seine, which will be festooned with electric

globes, and to the bridges of the Esplanade des Invalides, while illuminated boats, taking part in a sort of Venetian fête, will ply about the river.

For the solution of the difficult question of interior transportation at the Exposition,—a question presented in a circular issued by the ministry of commerce and industry in August, 1897,—the examining committee had to choose between five principal projects, all of them electrical. The French Thomson-Houston Company wished to establish a single track of one-metre gauge, and to install at Ivry a station of some 4,000 h. p., generating polyphase current. Sub-stations and transformers were to be established in the grounds of the Exposition for moving the trains, which were to consist of two motor-cars, each of about 160 h. p., hauling two, three, or four trailers. The Decauville Company also desired to build a one-metre-gauge railway, to be operated by electricity. The electric company which serves the region on the left bank of the Seine had an almost similar project, the electrical energy to be generated in its own station. The fourth project, that of M. Francq, proposed a double track of standard gauge and accumulator vehicles. The fifth and last proposition, that of M. de Mocomble, was adopted. The plan comprises two parts; an electric railway with one-metre gauge, and a moving walk-way of two speeds.



SECTION OF MOVING WALK-WAY.

This last part of the project was accepted on account of the excellent results shown by such moving walk-ways at Chicago, in 1893, and Berlin, in 1896; but in this case they are not to operate through a distance of a few hundred metres, as at the former Expositions, but are to run through the Champ de Mars to the Esplanade des Invalides and back by the Quais to the point of starting, thus making a circular path nearly five kilometres in length. The exact route is the following, shown also in the plan (page 997): Beginning

at the Quai d'Orsay, through the Avenue de la Bourdonnais, Avenue de la Motte Picquet (outside the limits of the Exposition), Esplanade des Invalides, and Rue Favart. The walks will be carried upon a metallic trestle-work, consisting of two parallel girders resting upon cast-iron pillars 6 metres high. Passengers go up to the walk-ways at the principal stations by a moving inclined plane; at the intermediate stations there are staircases. Arrived at the level of the walk-ways, the passenger finds himself upon a fixed platform, P (page 998), or sort of walk, 0.9 metre wide, upon which he can stand while waiting for a convenient opportunity to get on the second platform. A light iron railing guards the exterior of this stationary part of the walk. The second platform, P', 0.8 metres wide, moves at the speed of 4 kilometres per hour, its edge running close to that of the stationary walk. Finally, a third platform, P'', 1.30 metres wide, runs at the speed of 8 kilometres per hour. Upon this are mounted benches, each seating three persons and all facing in the direction of the movement of the apparatus. The two platforms will have movements entirely independent of one another. They are furnished with an axial girder, A, placed under the floor and resting upon rollers situated between the two rails of the track at every 6 metres. These wheels are not all equipped with motors, the motor wheels being 39 metres apart. To each of these is connected a motor of 6 h. p., which in this way transmits motion to the axial girder and to the platforms themselves. A special generating-station will probably be built, to furnish about 400 h. p. for these motors. The carrying capacity, or number of seats per hour, is estimated at 38,880, the maximum speed of motion of any part of the apparatus being 9.72 kilometres per hour. M. de Mocomble has offered to pay one centime per passenger carried, the fare being ten sous, whatever the distance traversed.

The small electric railway will run around the grounds in a direction opposite to that of the moving platform, and will have a single track of one-metre gauge. The trains will comprise three trailers and one motor-car, carrying four motors of 35 h. p. each. These trains will accommodate 9,500 passengers per hour, the fare charge being five sous. The system of traction will be left to the choice of the *concessionaire*, —between the overhead trolley and third rail. The commission, before definitely undertaking the work of construction, have invited M. de Mocomble to give a trial of his moving platforms upon an enclosed circuit of 350 metres. These experiments will probably take place in two or three months.

The cost of installing the platform is estimated at 7,000,000 francs. It will thus be necessary, during the two hundred days of the Exposition, in order to repay this cost, to take in 35,000 francs

per day, or fares from 70,000 passengers. The walks will be in operation for 14 hours each day.

The greatest inconvenience about this project is that it serves only the left bank of the river; the Champs Elysées and the buildings on the right bank of the river will be practically isolated. This difficulty was found to be insurmountable, and there is some question whether or not there are bridges enough to connect the two parts of the Exposition on the opposite sides of the river. It was to remedy, in part, this defect that the commission accepted a recent project of an aerial car (a sort of telpherage scheme) suspended by rollers on a taut cable and hauled by another cable wound up at one side or the other, on windlasses, by electric motors. This extraordinary arrangement is to be erected about 50 metres below the new Alexander III bridge. The conductor of the car will operate it through signals transmitted to the motors on the banks. An electric lantern will illuminate the front of this curious vehicle. The view which will be obtained during this flight of 118 metres, at 9 metres above the water-level, of all the illuminations of the bridges and the shores of the stream, will certainly be unique and admirable.

This *résumé* serves to give an idea of the condition of work upon the Exposition and its plans and projects,—all that one can now foresee certainly. No other word than "immense" can describe the *rôle* to be played by electricity. More than 20,000 h.p. will be used for the lighting alone of the grounds and buildings; in addition, 10,000 h.p. will be used for motive power; and there is actually under construction, at Molineaux, outside the fortifications, a supplementary power station of considerable size, of which the total horse power has not yet been made public.

EDITORIAL COMMENT

A general view of the technical literature of Europe and America month by month reveals certain waves, or groupings, showing the tendency which various subjects have to attract attention simultaneously in different parts of the world. Thus The Engineering Index this month contains titles of numerous papers upon subjects relating to public health, sewage-disposal, pure-water supply, and general sanitation, there being an undoubted revival and growth of public interest in the application of engineering methods to the prevention of disease and to the preservation of public health.

* * *

Again, there appears to be a similar awakening in everything relating to workshop administration, including organization, cost-keeping, provision for depreciation of plant, and introduction of improved machinery, these subjects being discussed in leading articles appearing in prominent journals on both sides of the Atlantic. It is beginning to be appreciated generally that success in engineering work, commercially considered, depends very greatly upon the manner in which the problems of shop administration are treated, hence the interest taken in such matters in the technical press.

* * *

In the domain of electricity there is little novel to be noted; but, at the same time, the extension of the application of electricity to power transmission goes steadily forward, there being the customary proportion of articles descriptive of hydraulic and electric power plants. Papers concerning the great stations at Paderno and Lyons, and the proposed control of the Swiss Rhine, have appeared; while numerous examples of electric power application, notably in mining work, are described.

* * *

Railway affairs contribute several subjects of interest and importance to the list of articles in the Index, and from each side of the ocean comes information concerning great terminal works. In Boston the huge Union Terminal is fully described in several journals, while the progress of the work on the prolongation of the Orléans railway, in Paris, and on the construction of the new terminal of the Quai d'Orsay, is recorded. The subject of train speeds continues to be discussed, and the remarkable performance of the new compound engines of the Northern Railway of France, in regular service, is a subject of admiration and comment. A closely-related topic is that of train resistance, and the results of important tests, as well as the discussion of methods of computation of the resistance of trains of various weights at different speeds, form the subject of several papers.

* * *

Interest in both the Nicaragua and the Panama schemes for the isthmian canal continues, especially in view of the prominence of the question before the United States Congress, the publicity given to the report of the Nicaragua Canal Commission, and the passage of the bill by the United States Senate, all of which furnish occasion for comment and criticism in the technical press. The report of the Senate committee upon the regulation and control of the Mississippi river has also attracted much attention in civil-engineering circles in the United States, the document being an important presentation of a problem of great consequence to a number of States.

* * *

A kindred subject to that of the control of rivers is the distribution of water for irrigating purposes, and, especially in the western United States, progress has been made in introducing more rational and scientific methods of measuring the flow of water for irrigation than those formerly in vogue.

Other matters of interest to the civil engineer are the growing subject of reinforced concrete construction, lately discussed theoretically in papers presented before the French Academy; practical applications of the method to bridge-construction are noted both in Europe and America. Fireproof building construction is also attracting renewed attention, this question doubtless being influenced by the behavior of recent structures in actual test.

* * *

Various papers upon the progress of the construction works of the Paris Exposition continue to appear, there being a noteworthy presentation of the engineering features of the works at a meeting of the American Society of Civil Engineers, the proposed transportation features being especially considered. The general activity which is reported upon the exposition works appears to confirm the assertions that no delay will be permitted to interfere with the completion of the various structures by the appointed date.

* * *

The launch of the White Star steamship Oceanic has attracted attention mainly because of the fact that the dimensions of the Great Eastern have at last been exceeded; but, from the point of view of the shipbuilder, this latest addition to the transatlantic fleet is of interest because of the improved methods which have been employed in her construction, and the probability that the success which has attended the use of power tools to so great an extent will cause their employment in other yards than those at Belfast.

* * *

In the field of steam engineering the subject of multiple expansion continues to evoke discussion, and, while papers in the continental press contain methods for determining the best cylinder ratios for triple- and quadruple-expansion engines, the tendency in America is rather to look with favor upon the use of compounding in two cylinders only, with a much larger ratio than that formerly employed. The influence of constructive details upon economical performance and upon the possibility of the attainment of higher rotative speeds also receives attention. The subject of smoke prevention is still discussed, but mainly with regard to the suppression of a nuisance, and not as a feature of economy in combustion.

Automobilism remains prominent in certain of the technical journals, especially in France, and there is every evidence that mechanically-propelled vehicles are passing from the limited sphere of the pleasure carriage to the wider field of general commercial service.

Artificial refrigeration forms a fertile subject for papers relating to the practical application of thermodynamics, and reports of tests and accounts of special installations furnish material for several valuable articles. Many papers on machine tools and special methods of work appear in the department of mechanical engineering, a field which has maintained its usual activity during the month.

* * *

The technical literature of mining and metallurgy is particularly full, and both in the department of mine operation and of the subsequent treatment of products a great variety of papers is found. The matter of specifications for structural steel forms a subject of animated discussion among manufacturers and inspectors of steel in the United States, and the relations between the chemical composition and the physical characteristies of steel are made the basis for proposed modifications in existing methods of specification.

The application of electric power to mining plants is making rapid progress, and, in Germany especially, some notable installations of electric underground pumping machinery are recorded. Methods of preventing mine explosions, and improvements in life-saving apparatus continue to receive notice, and, on the continent at least, it is not too much to say that improvements in this important line of work are progressing most actively.

* * *

As is usual at the beginning of the year, there are many reviews of the progress in various departments of engineering during the past year, and while there are no very

notable achievements or discoveries to be recorded, yet on every hand there is abundant evidence that sound and material progress has been made; a progress which may be more apparent when thus viewed as whole, than when noted, as here, from month to month.

* * *

General H. L. Abbot, whose computations Mr. Hunter quoted in his article on the Panama canal in our February issue, advises us that the water impounded by the Alhajuela dam is sufficient to feed the canal "during the three months of the 'dry season' when the normal flow of the river is insufficient. This flow has been carefully determined by actual measurement, and the minimum volume noted in any month has been used in the estimate." He informs us further that the estimate of $100,000,000 for completing the canal is *not* inclusive of the cost of administration or of payment of interest out of capital during the period of construction.

* * *

Mr. Orcutt expresses, in this issue, his belief that "the majority of the best mechanical engineers in America have no college education." This may be the fact —though the old order is fast giving place to the new—without affording the slightest ground for his inference that "college training . . . as at present carried out, seems" to "unfit a man for practical machine-shop work."

The technical school is of comparatively recent growth. To many engineers who are now most prominent and most justly honored it was not accessible. They succeeded without it; by no means does it follow that success would not have been more rapid if the road had been easier.

It is part of their triumph to have replaced empiricism by the higher knowledge of properties and laws which enables the projection of new work far beyond the range of experience. The "college training, as at present carried out," is generally designed only to place this portion of the work of the great pioneers within the reach of the following ranks of the profession. It proposes to give a clear and accurate knowledge of the "why," and thus aid in a speedier and more thorough acquisition of the "how."

Rarely, the technical school weakens its case by pretending to give its students the instinctive readiness which comes only from long practice; but the institution should not be condemned by its infrequent abuse. Many things in the training of a physician or a surgeon must be gained by long practice and observation in the clinic and the hospital; one would hardly, on this account, condemn medical education or consider the after training "a corrective dose."

* * *

Gen. Otis has repeated, at Manila, the object lesson which Gen. Lord Kitchener made so terrible as well as so brilliant at Omdurman—the lesson of the immeasurable supremacy conferred by mechanical skill.

Of course, discipline must be granted a most important factorship in either result; but there is some ratio at which fanaticism, or mere blind dash, will overcome any discipline; there is practically no comparison possible between the fighting tools and the fighting engineering of the savage and those of the Anglo-Saxon.

It is a bitter way the white man has of beginning his teaching of the "silent sullen peoples," this

> "Landin' 'isself with a Gatlin' gun,"

but it proves the power of civilization in a way there is no possibility of their misunderstanding. It is the "concept they have," from which he can proceed to "the concepts they have not" yet,—the concepts of sanitation, of water and food supply, of proper buildings, good roads, intercommunication, and industry. The engineer as a war-maker justifies his sternness by opening the door to the engineer as a health-maker and a wealth-maker.

* * *

When acetylene leaped into sudden prominence as an illuminant it was feared that electric-lighting stations might suffer from its competition. Now it is becoming evident that the effect of its general introduction will be really beneficial to the electricity-supply industry.

The brilliancy of artificial lighting has increased astonishingly. Until gas gave them a new standard of illumination, our ancestors were satisfied with dim and flickering candle-light,—but once accustomed to the more powerful light they could not return to the visible darkness of the rush-light epoch.

When electric light appeared it was seen that gas was inferior in steadiness, power and color. But, notwithstanding, the consumption of gas was increased by the growing extension of electricity supply, simply because the greater brilliance of the new illuminant set a new standard for lighting. For identical reasons the effect of the incandescent gas burner upon the electric-lighting industry has been beneficial. It seems, therefore, that the more general use of acetylene will similarly act as a stimulant to other branches of the illumination-supply industry.

* * *

It is not generally known that the theoretical limit of attainable candle-power from acetylene, made from calcium carbide produced in an electric furnace, is somewhat less than that actually obtainable from incandescent lamps actuated by the same amount of electrical energy. As a matter of fact, a given quantity of light produced by burning acetylene necessitates to-day an expenditure of from two to three times as much energy in making the carbide as would be required to generate the same light with incandescent lamps. This difficulty is only apparent, however, because inexpensive water-power can be used for making the carbide, which may be transported to any distance. In a sense, calcium carbide represents the stored light-producing ability of the energy used in its manufacture.

* * *

In the same connection another singular fact is apparent. There is absolutely no standard or unit of illumination. An architect or an engineer confronted with the problem of lighting an interior, for example, with whatever sort of illuminating agent, has no more reliable criterion to guide him than common experience. His method of solution will inevitably resolve itself into guess-work. He does not know what intensity of light he wishes to attain, and if he did he would not know how to set about procuring it. Heating and ventilation have been reduced to fairly exact sciences in which, at least, there are degrees of intensity and units of measurement; but there is nothing tangible about lighting. The prevailing rule seems to be that a little more than enough light is just about right.

* * *

In the January number of THE ENGINEERING MAGAZINE a short editorial paragraph called attention to the fact that the supply of gutta-percha is limited, and that the Pacific cable, so much talked about nowadays, would probably consume most of the gum in sight. Just why the daily press should have united in a complete misunderstanding of the item is a little hard to understand, but from one end of the United States to the other newspapers have copied it, and, with about three exceptions, have used as a heading either "Rubber is Scarce," or "Hurry Pacific Cable or Rubber May Be Scarce." As the item in question did not mention rubber anywhere, and as rubber is far from scarce, it is interesting to see the extraordinary unanimity with which the copying journals assumed that the paragraph meant rubber when it said gutta-percha. Perhaps the first man made the mistake and all the rest copied him; or—dreadful thought!—perhaps the item was spread about by someone who thought he would be able to bull the rubber market with it. This seems a good opportunity to say that, while gutta-percha is not plentiful, there is not the least scarcity of rubber, as many new areas are producing it and both quality and quantity of the product seem to be satisfactory and sufficient.

THE BRITISH PRESS

Review of Leading Articles

The Present Status of Sewage-Purification.

AMONG the papers at the Birmingham congress of the Sanitary Institute were several of importance upon various phases of the important question of sewage-purification and -disposal, the whole, together with the discussion, forming an excellent record of the present status of the subject.

The papers were by such well-known experts as Messrs. Kenwood, Butler, Rideal, Scot-Moncrieff, and Adeney, the discussion including remarks by Professor Frankland, Mr. Dibdin, Dr. Sims Woodhead, and the authors, so that the papers and the discussion represent a consensus of opinions of specialists.

It now seems to be generally admitted that bacterial action is the one method of sewage-purification, and that the only question is that of assisting nature in this work, and thus accelerating, and to a certain extent controlling, this action. As Professor Frankland remarked, every particle of the sewage of our forefathers had been disposed of by bacteriological processes, and, so far from being entirely novel, such processes are as old as life on the globe. This fact was also emphasised by Mr. Dibdin, who showed that, the more the question was studied, the more clear it became that the main reliance had always been upon the action of the micro-organisms.

The most important lesson learned in the course of recent experience is that the continuous life action going on in the foul water from the time it is first produced until it is discharged in a purified condition must not be interrupted. Any treatment by excessive doses of lime, carbolic acid, or any material which acts as a disinfectant, will arrest the natural purifying action for a time, although this will reassert itself and continue its action at a later point.

It seems to be a well-established fact that disease germs are not conveyed by the sewage effluent. Pathogenic bacteria do not thrive at a temperature much below blood heat, and are rapidly crowded out and destroyed by the immense numbers of ordinary bacteria present in sewage. Experiments by Dr. Sims Woodhead and Dr. Pickard seem to demonstrate that the typhoid bacillus does not survive in the septic tank, and that in the filter beds there is a further biological elimination, "so that there is no chance whatever of the filtered effluent causing typhoid fever, if passed into the river."

There seems to be no doubt that both the anaerobic and aerobic processes are of value in connection with sewage-disposal, the former for the solution of solid matter and the latter for the purification of the liquid sewage.

When the sewage is submitted to the liquefying action of the anaerobic bacteria, in an air-free dark space, the solids are dissolved to simpler organic compounds, with the final production of carbonic acid, ammonia, and volatile gases. The experimental tank at Exeter has never been cleaned out, and it is an undoubted fact that solid materials, such as paper, string, rags, feathers, etc., do disappear, and the sewage is converted into the liquid form.

When the liquid form is attained, the aerobic bacteria may be depended upon to produce the final purifying result, and Mr. Adeney has outlined very clearly this portion of the subject.

The following facts are known;

"1. That the agents which bring about the purifying changes are bacteria;

"2. That the germs of these organisms exist practically everywhere in nature;

"3. That the ordinary bacteria of nature can attack, and completely oxidise, probably most, if not all, known organic substances, with the exception of antiseptics;

"4. That the chief condition necessary for the continued healthy life processes of these organisms is an adequate supply of

oxygen in the free state or in certain forms of combination.

"This holds good for the solid matters in suspension, as well as for those in solution.

"5 That the chemical changes set up by these organisms, under the condition of a sufficient oxygen-supply, result in the complete breakdown of the organic matters in a foul water, and in their conversion to carbonic acid, ammonia, water, and nitric acid, together with the formation of small quantities of colouring matters, which, although organic in composition, are not to be regarded as polluting matters, since they are to be found present in more or less quantities in all waters, including first-class potable waters.

"The process, then, of purification of foul waters by natural agencies is a true bacterial fermentation,—a process presenting *per se* no danger to public health, if an adequate supply of oxygen be maintained during its continuation, but capable, in the absence of such an adequate supply, of engendering conditions, in the highest degree dangerous to health."

It will be noticed that Mr. Adeney asserts that the anaerobic bacteria are capable of decomposing both solid and liquid matter, but this is a point about which experts as yet disagree.

Notwithstanding some minor differences of opinion, there is no doubt that rapid progress is being made in the successful handling of both processes, and, in the words of Mr. Scott-Moncrieff, the bacterial purification of sewage is certain to be generally adopted at an early day as a thoroughly satisfactory solution of the question.

The Organisation of Manufacturing Works.

IT is everywhere becoming apparent that manufacturing supremacy depends to a very great extent upon systematic organisation, and that the only way in which the growing competition with British industries can be successfully met is by a systematic reorganisation, not only of machine tools and methods of work, but also of the conduct of manufacture.

An interesting paper read before the North East Coast Institution by Mr. Tom Westgarth treats mainly of the organisation of shipyards and engine-works, but many of the points apply to manufacturing establishments in general.

In the first place, it is a mistake for an establishment to attempt to make too great a variety of products, and it is not wise to attempt to make in a general works machinery and parts of engines which are specialties of other makers; for instance, it is probably cheaper to buy pumps and auxiliary engines than to make them. In many cases it is not well for engine builders to make either their own castings or their own forgings, unless they have enough work to keep a foundry and a forge busy all the time.

The arrangement of tools is an important matter, and one to which more attention is given in the United States than in Great Britain.

"In placing tools, care must be taken that the rotation of work should be continuous. The plan, frequently adopted, of grouping similar tools together, as, for instance, having all planing machines in one part of the shop and all drilling machines in another, is not always satisfactory, and sometimes involves unnecessary labour in carrying work to the machines.

"The tools should not be placed in groups of one kind, but with a view to the particular work which is to be done in conjunction with other machines."

The importance of a well-organised tool store, in which should be kept tools, gauges, templates, working drawings, etc., is emphasised, and the necessity of having the care of these tools in the hands of a skilled mechanic, who can superintend the repairs and construction of new tools, is shown.

Mr. Westgarth makes some excellent suggestions regarding the administration of workshops.

"With regard to the staff, it is quite as important that the staff should be both sufficiently good and sufficiently large for the work to be done as to have a well-laid-out works with good machinery. It is, of course, easy to err upon the side of having too large a staff, but a very common error is to have the staff too small.

It is impossible to calculate the loss in a shipyard or engine works which will take place if the drawing-office is undermanned and the works behindhand.

"Most capitalists quite agree as to the necessity of having the best tools, and plenty of them, but the writer is afraid the majority consider that a large staff is a waste of money. Not only is it important that the drawing-office should be well manned, but also the office, and particularly the cost-keeping department.

"It is of vital importance that the costs should be kept up to date, and an abstract of costs furnished, if possible, weekly, and made up to the end of the previous week, to the responsible managers, so that they may know how costs are progressing."

So far as the question of costs is concerned, it is quite possible, even in the most extensive establishments, to install cost-keeping systems which enable the cost of any piece of work to be ascertained upon inspection at any stage of the work.

The question of finishing work in stock is also touched upon by Mr. Westgarth, and the economy of completing machines in lots, rather than in single orders, is shown to over-balance in most cases the loss of interest on the capital locked up.

In a great number of cases the systematisation of designs for the express purpose of enabling many parts to be made in quantity is the true secret of economical production, and, although the parts may belong to machines of different classes, the grouping of sizes and the judicious arrangement of details to permit duplication of parts are among the secrets of the reduction of shop costs.

Payment by results is strongly recommended, from the managers and the foremen down to the workmen, the managers being paid partly by a percentage on the profits of the work of their departments, and foremen partly by a bonus upon the quantity of work turned out, while the piece-work system is advised for the workmen.

"It should be clearly grasped by capitalists that the days of very large profits from engine building are past. The competition for work is now so great, and the standard of requirements so high, that it is only in good years that a large profit can be made; and experience has taught us that trade fluctuates so much that good years are invariably followed by bad ones, and therefore, when a large profit is made, it should certainly not all be divided, but part should be kept for a reserve fund to equalise dividends in bad years.

"If an engine works can pay steadily 5 per cent. on the capital, and gradually accumulate a reserve fund, after making proper provision for depreciation, and taking care to buy new machinery and tools, and also make minor extensions from revenue, capitalists should be satisfied that the investment is a good one, and, if such a policy could be carried out, there would be much less difficulty in getting capital subscribed for manufacturing purposes.

"Manufacturers are not entirely free from blame for the present peculiar way in which the investing public will much more readily put money into mines and all kinds of speculative investments abroad rather than into shipbuilding and engineering companies at home."

The Increased Efficiency of Coal.

THE importance of obtaining the highest possible efficiency out of the fuel used in the various operations in the arts is the subject of an excellent article in *The Colliery Guardian*, and the comparisons there given of the advances made during the past thirty years in the economical use of coal show a material progress.

In the case of marine engines some very interesting figures are given from British warships, the average fuel-consumption between 1861 and 1872 being 4 to 5 pounds per h.-p. hour, a figure which was reduced to 2.75 pounds in 1878, and to 2.5 and even 2 pounds in 1888, while at present a horse power is obtained with 1.5 pounds of coal per hour in a number of instances.

This continually-improving economy has been attained by the combination of several improvements, the principal being pressure, multiple expansion, and improved construction, by which useless resistances and wastes were reduced. The large losses of steam due to cylinder condensation

have as yet resisted any reduction by any other means than that obtained by multiple expansion and jacketing, although superheating has given most encouraging prospects as to further improvement in steam economy.

It is not only in marine engineering that increased fuel efficiency has been secured; both railway and stationary practice show good results.

On the London & North Western Railway the latest figures show a fuel-consumption of 35.7 to 38.8 pounds of coal per engine-mile, as compared with 48.5 pounds a few years earlier.

American stationary engines have been constantly improving in steam economy; while in 1870 the most economical mill engine used about 20.5 pounds of steam per h.-p. hour, this had fallen to 16.5 pounds in 1873, while at present there is a record of 12 to 13 pounds.

A similar economy has been obtained in connection with the manufacture of coke. Not only are the bye-products recovered, but a greater percentage of coke is produced from an inferior quality of coal, and the resulting fuel is of greater efficiency. With the old beehive oven, only about 65 per cent. of coke was produced from a given quantity of coal, and the bye-products were lost, while, with the modern forms of recovery ovens, there are no waste products, and 75 per cent. of coke is obtained.

"In regard to the blast furnace, the increased efficiency of the coal and coke used is very clearly shown in the fact that, while in 1870 the consumption of fuel per ton of pig was 23 hundredweight, it is now less than 20 hundredweight, in some cases falling as low as 17 hundredweight."

These results are largely due to mechanical improvements in the furnaces and a better knowledge of the chemical processes involved. More work is being got out of a pound of coal than it was thought possible to get ten or fifteen years ago, and at the same time less waste is incurred.

"Another direction in which increased efficiency of coal has been exhibited is in the advances which have been made in the production of water gas. In the old water-gas generator, of small size, only from 30 to 38 per cent. of the value was utilised, out of 85 per cent. carbon in the coke. Now, under the newest system, the calorific value of water gas from one ton of coke is over 82 per cent.

"These instances might be multiplied, no doubt, but they at least serve to indicate the movement which is going on in industrial affairs, which is tending to eliminate waste and to extract every unit of work and value from the substances and materials which are, in the majority of cases, becoming scarcer every day."

The Market for Traction Apparatus.

THE effect of injudicious legislation in hampering trade is nowhere better shown than in the present condition of the British market for electric-traction apparatus. The tramways act, combined with the conservatism of local authorities, has so narrowed this field of enterprise that there has been no incentive for the British manufacturer to prepare to execute orders for electric street-railway machinery, the consequence being that such orders are, for the most part, placed in the United States.

Commenting upon this state of things, the *Railway World* says: "We are not inclined to complain of this: on the contrary, it is fortunate for companies and corporations that the resources of the great American electrical manufacturing establishments are at their disposal on such favourable terms; for the simple fact is that British makers have not yet put themselves in a position to meet the demands, particularly as respects the important element of time in delivery." The large, and by no means cautious, market that American manufacturers have enjoyed, and the lack of conservatism among manufacturers and managers, have aided in no small measure the tremendous exploitation of electric tramways in the United States. "Experiment is the delight and extravagance of the manager of every undertaking, and far be it from us to say that in the end it is not justified. It has, at least, produced sixteen thousand miles of electric railways in the States, and it has invaded this country to such an extent that there is scarcely an electric tram-

way that is not eloquent of its success."

The major difficulty with the British manufacturer of traction apparatus seems to be that he has not prepared himself to meet competition from abroad. This unpreparedness is evident, not only in the electrical manufacturing trades, but as well in most others where the American machine tool is bringing its product into competition with the more costly output of the British machine works. The specialisation of electric-tramway apparatus has been carried to the highest point in America; designs and patterns have been standardised, after costly, and often disastrous, experience has shown the forms fittest to survive; manufacture in its strictest sense—the duplication of a standard machine with the least expense—is carried on universally, departures from the accepted design being almost unheard of. With this specialisation of works and patterns, assisted by the use of the most economical methods and tools, the British manufacturer is in no position to compete. He must be content, first, to learn new methods of organising his work and the use of new tools,—experience acquired only after repeated failures; but he must also be freed from the limitations of the tramways act and the dictation of the trade-union.

All over the continent there is awakening a lively interest in electric traction. Much of the apparatus employed is of American origin, but British firms have been fairly represented, and have shown that they are able to produce excellent apparatus. It seems that only the British isles are still asleep under the soporific effect of ultra-conservative, though well-meant, legislation.

The Industrial Prosperity of Great Britain.

MANY attempts have been made to deduce the industrial condition of a country by a comparison of its exports and imports, and, when the latter exceed the former, some excellent people wonder how long the resources of the country can stand the drain.

A very excellent editorial in *Engineering* upon the subject of British exports and imports, based upon a recent paper before the Society of Arts by Sir Robert Giffen, shows that there are many conditions besides exports and imports which enter into the prosperity of a nation, and that among these the returns derived from the work of the engineer form no insignificant part.

Ever since 1854 there has been an excess of imports over exports, and, if this alone were any indication of the condition of the country, bankruptcy should have been reached long ago; hence there must be some fallacy in the argument.

The apparent anomaly of prosperity for a nation which persists in spending more than it earns is partially explained, according to Sir Robert Giffen, by the fact that the values are not expressed by the same standard, a ton of coal being a ton of coal whether in a mine or in a ship's bunker, but valued at four or five times as much in the latter case as in the former. The official returns assess imports at their value on arrival, while the value of exports is calculated on their departure. To the discrepancy occasioned by this inconsistent mode of valuation about sixty of the eight hundred and seventy-five millions of Great Britain's adverse balance of last year may be charged, this being what Sir Robert Giffen calls the "invisible export."

Another source of revenue to England lies in the large amount earned by the commission business, due to the fact that she is the centre of the monetary transactions of the world; besides which the business of ocean transport is largely in British hands, and the profit from the transport both of merchandise and passengers should be included.

Then there is the so-called "private income" coming to England in the form of returns on English capital invested in other countries. "There are English partners in foreign businesses who send their money home, while the share owned by British residents in State loans, foreign railways, water-works, and other public undertakings is enormous."

Taking these returns, together with the

sums remitted from India for salaries, pensions, and annuities, we have something more than seventy millions a year to be added to the revenue of Great Britain from the "private fortune" of England as compared with trade and professional earnings, this representing a principal of not less than 1,500,000,000.

Viewed in this light, it will be seen that the excess of imports is to a great extent paid for with the returns from invested profits, and represents in large portion the tribute paid to enterprise, thriftiness, and natural advantages. England makes all the railways, harbours, roads, and bridges she needs, and then lends her balance, receiving in return an excess of imports.

It is in this form of wealth that the work of the engineer appears; hence a little thought will show that the product of genius and brains is an invisible export the value of which can hardly be counted in a monetary sense.

"In other words, our industrial prosperity is in our own hands, and, so long as England remains true to itself, its commercial influence is not likely to wane, although it cannot in the nature of things retain the overwhelming preponderance over that of other nations it once possessed. Enough trade will, however, remain to afford the comforts of an advanced civilisation, and we should be churlish indeed if we grudged other people a share of the increasing happiness that has come to our race in these later days of progress; a progress in which the engineer has played the most conspicuous part."

The Deterioration of Steel Rails.

THE advances which have been made of late in the study of the physical properties of metals, especially in connection with the use of micro-photography, lend especial interest to two papers recently presented before the Institution of Civil Engineers,—one by Mr. William G. Kirkaldy, upon the "Effects of Wear upon Steel Rails," and the other by Sir William Roberts-Austen on the "Microphotography of Steel Rails."

In the course of an examination of some rails which had broken in service Mr. Kirkaldy became convinced that the nature of the steel had been affected by the action of the loads.

It was found that the breakage of the rails resulted from failure commencing at the top surface, and not from the bottom, as appears to be the usual belief, the deterioration being confined entirely to the top, or running head. The deterioration seemed to be of the nature of a mechanical hardening of the surface under the action of a rolling load.

In some instances the hardening develops into a species of disintegration, minute transverse cracks being formed, which ultimately result in failure.

Since the bottom portion of a rail is not subjected to the hardening action of the rolling load, the metal in this portion may be taken as a fair representation of the original material, and the difference in the results of tests made upon the two portions serves to show the extent and character of the deterioration.

The deterioration having been determined for various specimens, there arises the important question: What is the best means of diminishing the action which produces these injurious effects? The causes of deterioration may be separated into those due to situation and those which depend upon the chemical and physical constitution of the rail itself.

The conditions due to situation include the effects of the stoppages of trains, which again vary, depending upon the place where the stop is made,—on a favourable, level piece of track, or on grades or other locations in which the brake action is more or less severe.

Injurious effects are produced also on rails situated at the starting positions of trains, where the skidding, or climbing action, of the driving-wheels comes into play. It is therefore important, in investigating any specimen of rail, that the nature of the location from which it has been taken should be known. The investigations of the micro-structure of rails, as indicated by Sir William Roberts-Austen, involve the use of etching and staining methods.

The most generally useful information

as to the structure of the steel is obtained by treating a highly-polished surface of a section with an infusion of liquorice in water, which stains the pearlite a dark tint and leaves the ferrite unacted upon.

When such a section is magnified between 100 and 150 diameters, the relation of the pearlite to the ferrite can be clearly seen.

Normal rails generally consist of patches of pearlite set in ferrite, but, although this structure is common to all rails, the ratio of the areas differs widely, the carbon increasing with the area of the pearlite.

The best condition for rail-steel is that in which the ferrite and pearlite appear in a closely-interlocking relation, while, if the ferrite appears in large enclosed polyhedrons, it indicates that the temperature before rolling was too high.

By conducting a careful series of experiments of this nature upon rails of which an accurate history, so far as location and service are concerned, has previously been obtained, much doubtless may be learned as to the causes and prevention of rail breakages; and the importance of obtaining a careful record of the duty performed by worn rails should in every case be recognised in securing specimens for investigation.

The Oceanic.

WITH the launch of the new White Star steamer Oceanic, of which an excellent description is given in recent issues of *Engineering*, the dimensions of the Great Eastern are at last exceeded, and the advances which have taken place in naval architecture and marine engineering in the thirty years which have elapsed since the construction of Scott Russell's great ship are such as to make some comparisons of interest.

So far as actual dimensions are concerned, the difference in size is not very marked; the Great Eastern was 680 feet l.w.l., 83 feet beam, and 57 feet 6 inches deep, with a displacement of 27,000 tons; while the Oceanic is 685 feet l.w.l., 68 feet beam, and 49 feet deep, the displacement being 28,500 tons.

It is in the powering of the two vessels that the great advance in marine engineering is most apparent, and one can readily see how far beneath the actual requirements the power of the engines of the Great Eastern was.

The Great Eastern was fitted both with screw and paddle wheels, the combined power of both sets of engines being given as 2600 nominal h. p., and the actual capacity being about 12,000 h. p., while the engines of the Oceanic are estimated at about 28,000 h. p.

In the days of the Great Eastern, rectangular flue boilers, with flat stayed surfaces were in vogue, with working pressures ranging from 15 to 25 pounds per square inch, while at the present time 180 to 200 pounds is the rule, 192 pounds being given as that adopted for the Oceanic.

Although the powering of the Oceanic is thus about double that of the Great Eastern, the increased economy of modern engines is such that the total fuel consumption should be decidedly lower. With simple engines and low pressure, six pounds of coal per h. p.-hour would have been a good result, while, if the performance of the quadruple-expansion high-pressure engines of the Oceanic does not show a consumption of less than two pounds, her builders will have good reason to be disappointed.

While no especial claims are being made as to the speed of the Oceanic, it is fully expected that she will make the run between Liverpool and New York within the seven-day limit from port to port, which means that, while on the high seas, a speed of 475 to 500 miles per day must be maintained, corresponding to a rate of about 18 knots. The speed of the Great Eastern, under favourable circumstances, was about 14 knots. Until practically a whole day can be knocked off the transatlantic record there is not very much use in endeavouring to exceed this speed, since the only result is that of requiring the arriving vessel to lie in harbour over night, the nominal gain being offset by the impossibility of landing passengers after nightfall.

Some especial features of the Oceanic may be noted here, although fuller infor-

mation concerning the machinery is expected hereafter. All parts of the propelling machinery are practically doubled, thus enabling the ship to proceed, no matter what portion may fail. The thrust block, the main point of application of the propelling power, is duplicated for each engine, each thrust bearing being of sufficient capacity to receive the thrust of its engines. The main steam pipes are of welded steel, with butt straps riveted on, and the smaller pipes are of solid drawn steel.

Notwithstanding the experiences recently obtained with the Kaiser Wilhelm der Grosse, the Oceanic is not to be fitted with independent air-pumps; but the air-pumps are so arranged as to be operated by side levers from the main engines in the usual way, while the auxiliary machinery is of the usual type, and presumably of corresponding steam-consuming capacity. In these two latter features it is to be regretted that recent experiences have not been permitted to guide, but the considerations of certainty and convenience have been placed before that of operative economy, and, when the conditions of the service are taken into account, this is seen to have been probably the wiser course.

English and American Machine Tools.

A NUMBER of letters have recently appeared in the correspondence columns of *The Engineer* upon the well-worn subject of the relative merits of English and American machine tools, and while personal preferences doubtless entered into much of what was written, yet many of the questions are of immediate practical importance.

In the first place it appears that the real question at issue is not altogether the nationality of the tools, so to speak, but rather the importance of replacing antiquated tools by those of modern design and operation. As one of the correspondents well remarks: "We have many times seen machines which were in use 'many years ago in my father's time'—as we have been told—doing good work, and which, by the way, could have been done at one-third the price by adopting later methods." Such establishments certainly need modern tools and whether of English or American make matters little, as either would be a vast improvement over such antiquated equipment as is indicated by the reverence in which the tools of "my father's time" are held.

It is certain, however, that those English tool makers who maintain the excellence of English tools do so by showing the similarity of their products to those of the leading American builders, and in fact the principal difference between works equipped with English and American tools seems to be in the output of the machines. For this the workmen are doubtless largely responsible, since it seems very difficult to obtain even with American tools the same degree of production as is obtained with the same tools in the land of their origin.

It really seems as if most of the discussions which are held upon this question of different kinds of tools are rather at cross purposes, and that there is not much difference of opinion as to the value of automatic machines, specialised systems of manufacture and modern methods generally; all of these are understood to be good things, and more, as the only means by which foreign competition can be successfully met.

The real trouble lies in the fact that the equipment of existing works with complete modern plants means the immediate sinking of much which has been carried for many a long year as capital, and which can only be discarded at the risk of cessation of present dividends, and the possible requirement of assessments. It is difficult to see, however, what other alternative there is, and as matters look at present it seems as if the old establishments will either have to expend large sums in replacing their antiquated equipments, whether with English or American tools matters little, or else submit to be distanced in the competition either by home establishments of more enterprise or later origin, or by the pushing foreigner who is already well within the gates.

THE CONTINENTAL PRESS

Review of Leading Articles

House-to-House Electric Distribution.

IT is interesting to observe the social effects that follow the introduction of a new power. Prior to the invention of the steam engine there were no great aggregations of workmen in factories where common sources of power were utilised; there were, indeed, but few applications of other power than that furnished by the muscular labour of men or animals,—save, perhaps, where a few water-wheels turned mills. Industries, such as weaving and spinning, were carried on in the houses of the workmen, and it was not until the superiority of power-driven machinery became manifest that the aggregations of workers and machines called factories came into being.

In the ribbon industry of France the patriarchal system of working is still in vogue. Each workman, or family of workmen, has his or its small ribbon-looms, the materials for weaving being supplied by a *fabricant*, who pays the workers when the ribbon is returned to him, a piece-rate for their labour. Until very recently these little looms have been driven by hand-power. While this arrangement served excellently to keep families together, so that the aptitude or taste of the younger members might be trained in the traditional way, it still left much to be desired, and, in the St. Etienne region, it seemed that the ribbon industry was doomed to extinction, or to the more economical collection of its members under factory roofs.

The divisibility and ready application of electric power have averted these calamities, according to a highly interesting note by M. Edouard Simon, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*. In the region referred to the factory has been actually spread out, by means of electrical power distribution, until it includes the houses of the workmen. The looms are driven by electric power generated at a common source, and this economy introduced into the industry has already shown its beneficial effect.

The system of distribution and utilisation of power is of interest. The first works were put in at 15 kilometres from St. Etienne, with three turbines of 300 h. p. each, and a reserve of two steam-engines of similar power. Not long afterward this installation absorbed another at Pont de Lignon, forty kilometres from St. Etienne, and since that time the united systems have served twenty-four villages through one hundred and ten kilometres of trunk-lines. Three-phase alternating current at 5,200 volts is generated directly at the dynamos and fed to the main transmission lines at that pressure. At thirty points transformer stations are installed, feeding motors in their vicinity with current at 190 volts and lights at 110 volts. In the town of St. Etienne there are installed, in addition, three steam-driven generating stations, distributing energy at 190 volts directly, to avoid the dangers of the high-tension used on the country lines. In all, the various stations aggregate the respectable figure of 2,200 h. p.,—about 2,500 ribbon looms, 8,000 incandescent lights, and 100 h. p. of motors being operated from the circuits.

The general conditions under which power is sold to the workmen are somewhat singular. There is no attempt at a meter system, contracts being made on a time basis. Each ribbon-loom requires about one-quarter horse-power for its operation, and for each a flat rate of ten francs per month is charged. Deductions for stoppages are made when notice is given to the station, provided the stoppage is forty-eight hours or longer. Stoppages due to failure of the current supply entitle the weavers to a proportionate reduction in the charges for power. The motors, if furnished by the weaver, must fulfil certain specifications, those of about five prominent makers being acceptable. The power company will, however, furnish motors and install them free of charge, for a rental of one franc per month per

loom. Contracts for power are made for periods of four years, the prices of renewal at the expiration of this period to be the same or less.

"Thanks to this organisation, so minutely studied to fit the needs and the customs of the local industry, the double network of triple conductors ramifies all over the outlying quarters where the ribbon-weavers live. In some places the metallic conductors, suspended over the two sides of the road or the street, festooned from the many stories of the houses, crossing each other like gigantic spiders' webs . . . give a strange appearance to the sombre streets of high buildings with bare fronts.

"Other centres of production, where the work is equally a family matter, where little work-places distributed through country districts painfully struggle with foreign competition, may find, it seems, at St. Etienne valuable indications of methods to follow."

While this small beginning, in the centre of an old and established industry, is slowly establishing its value, it seems to point to a lesson that may be learned in many factory communities. The present system of gathering the machines and the power under one roof has compelled the workman to come to the factory; the electrical distribution method takes the factory to the home of the workman. In any industry where elements of artistic taste or traditional skill enter, as in the watch industry of Switzerland, this method of preserving the individuality of work, while avoiding the high costs of small and scattered prime powers, is admirable. It is another instance of the diffusive nature of electrical applications. The electric tramway has spread the area of towns, wherever introduced, and taken people further from their work; the distribution of power to them in their houses may still further check the centralisation that has begun to be so marked a feature of manufacturing towns. The social effect, and the effect upon the health of the community, of thus scattering aggregations of labourers can hardly fail to be most beneficial.

Automobiles in France.

UNTIL very recently France has held the leading position in the development of automobile vehicles, and, although other countries are now rapidly catching up to her, yet in the use of mechanically-propelled vehicles there is no doubt that more experience has been had in France than elsewhere.

For this reason an excellent review of the whole subject, in the form of a discussion by M. Barbet, in *La Revue de Mecanique*, of the motor vehicles shown at the exhibition recently held at the Tuileries, is worthy of notice.

It is only about four years since the modern revival of interest in mechanically-propelled vehicles for common roads began, although the idea of constructing such machines dates back to the invention of the steam engine, Watt having made the suggestion, and Cugnot having actually made an operative steam automobile in 1770.

Cugnot's machine was remarkably successful in practice, but was little more than a toy, and is still preserved as a curiosity in the Conservatoire des Arts et Métiers.

In England a number of well-designed steam coaches for common roads were built between 1820 and 1830 by Goldsworthy Gurney, to whom a memorial window may be seen to-day in S. Margaret's. Gurney's machines, being provided with excellently-designed water-tube boilers and judiciously-proportioned steam engines, were decidedly ahead of their time, and their use was abandoned.

The renewal of interest in automobilism is due doubtless to the general desire for travel, which has grown very much of late years; and the introduction of the bicycle as a general means of locomotion, and the enormous development of electric traction, have assisted in cultivating a demand for mechanical propulsion on common roads.

The early modern automobiles were provided with steam motors, the boilers being fired with petroleum, the most notable among these being the designs of MM. de Dion and Bouton, and M. Serpollet; but, after the invention of the light-weight high-speed petroleum explosion motors of

Daimler and Benz, general attention was drawn to engines of this type for motor vehicles, and the great success of the automobiles of MM. Levassor and Peugeot, at the trials between Paris and Rouen in 1894, and Paris and Bordeaux in 1895, established, in France at least, the superiority of the petroleum motor over the steam engine with petroleum-fired boiler.

The petroleum explosion motor, however, is probably only a temporary success, for the electric storage battery is very successful for motor cabs and pleasure vehicles, and steam appears to be the only motive power which can be depended upon for the so-called "heavy-weights," or merchandise and omnibus automobiles.

M. Barbet gives a great number of illustrations of the various types of vehicles exhibited at the Tuileries, but they show a general family likeness which renders the appearance and description monotonous. Most of them are curious hybrids between the work of the cycle factory and the carriage or wagon builder, with occasional glimpses of the product of the machine shop, and nearly all of them still contain ample evidence of the influence of the absent horse. In many cases in which there might be ample opportunity to enter the vehicle from the front, this most convenient mode of entrance, ordinarily obstructed by the horse, is now quite unnecessarily blocked by a useless dashboard with polished rod across the top for the support of the reins which are not there, the passenger being obliged to climb over wheels and mud guards while getting in from the side. In fact, nearly every carriage shows plainly that the body of the vehicle is but a crude adaptation of the old form.

A noteworthy exception to this crudeness is found in the work of the Maison Clement, in which, as might be expected, the lines of the bicycle are followed in the well-designed motor tricycles and quadricycles, while the Voiturette of the Compagnie Française de Cycles et Automobiles is another decidedly independent design.

The entire exhibition gives an excellent opportunity to see what has been done in France up to the present time, and, while many of the exhibits are good examples of what to avoid, the general result should tend to advance automobile construction.

Electric Traction in the Orleans Tunnel.

AFTER careful consideration of methods of tunnel-ventilation, the engineers of the Orléans railway have decided to adopt the radical method, suggested in these pages last month in connection with the Simplon tunnel, of using electric locomotives to haul trains through the subterranean part of the line, from the Place Valhubert to the Quai d'Orsay, in Paris.

The conditions of traffic on the new extension of the terminal line of this company lend themselves readily to electrical operation. Constrained by the growth of the city away from the location of its old station, the company found itself compelled to extend its lines to a point nearer the focus of things Parisian. Of the extension no less than 3,700 metres is tunnel, the terminal itself being below the ground-level and really a continuation of the subterranean works. The lighting of the tunnel required the establishment of a considerable electric station, and the application of electric power to trains on the terminal section required nothing more than an enlargement of this. The methods adopted are well chosen to meet the exigencies of the situation, being simple and such as have proven satisfactory in similar cases elsewhere. A description of the plans appears in *Le Génie Civil*.

At Ivry, more than five kilometres from the terminus at the Quai d'Orsay, three-phase current is generated at a frequency of 25 periods and a pressure of 5,500 volts. Three transforming sub-stations are in course of construction,—one at the generating installation itself, one at the old station, and the third at the new terminus. In each of the last two are groups of transforming mechanisms, one converting the three-phase high-tension current into direct current at 550 volts, for the operation of the electric locomotives; while the other, entirely independent of the first, converts to direct current at 500 volts for the five-wire lighting circuits. For the first transformation—that producing the

railway power current—the conversion is accomplished by rotary converters of 250 kilowatts each, running at a rate of 500 revolutions per minute. Accumulators are to be connected across the terminal of these, and will serve to greatly reduce the sudden and great fluctuations of load that will arise from the intermittent train service.

In order to completely eliminate the influence of the power-demand from the lighting circuit, the latter is operated from direct-current dynamos direct-coupled to synchronous motors operating directly upon the 5,500-volt mains. Fluctuations in the voltage at the sub-stations, due to the movement of trains, will, naturally, have no effect upon the steadiness of operation of these motors, so long as the frequency of the circuit remains the same.

For reasons of economy and simplicity the lighting circuits are operated on the five-wire system, the outer wires being at a difference of potential of five hundred volts. To compensate any unbalancing of the system, equalisers are introduced across each division of the wiring circuits.

The electric locomotives will be eight in number, each having two four-wheel trucks, a motor being mounted on each of the four axles. Their general arrangements will be similar to those of the Hoboken and Baltimore locomotives. The normal power of each will be 500 kilowatts, and the weight 40 tons. This power and weight suffice for the tractive effort needed to start a 350-ton train on the 1.1 per cent. grade under the Place Valhubert.

No delay will be occasioned by the shunting of the steam locomotive and coupling on of the electric engine, or *vice versa*, since this will be always done during the train's stop at the old Austerlitz station. It is estimated that the total cost of the electric installation, comprising the power station, locomotives, and third-rail system, will be 3,058,000 francs, a moderate price to pay for the cleanliness and satisfaction that will attend its operation of such a system. The fine new terminal and tunnel might soon have become a foul and soot-blackened cavern, like too many termini in other cities; but this sensible move of the Orléans railway company has made it certain that its station will always be pleasant. In these days of competition among railway companies for suburban traffic the question of cleanly and airy termini is one which is assuming the very first importance. The new station in Paris seems to furnish a most attractive precedent for the consideration of railway companies elsewhere.

The Power of the Rhine in Switzerland.

In view of the announced determination of the cantonal government of Zurich to appropriate for the development of power the entire flow of the Rhine as it passes through the canton, a general view of the extent and possibilities of the enterprise, as given in an article in *Le Génie Civil*, is a matter of current interest.

By establishing hydraulic power stations at suitable points, it is expected not only that all the electric energy necessary for the cities of Winterthur and Zurich will be supplied, but also that numerous minor centres within a radius of twenty-five to forty kilometres will be reached, the whole scheme involving an expenditure of upwards of 25,000,000 francs.

The area drained by the Rhine as it flows between Schaffhausen and Bâle includes nearly two thirds of Switzerland, the remaining third consisting of the basins of the Rhone, the Ticino, and the Inn, these rivers flowing respectively towards the west, the south, and the east. Taking the average rainfall over the area drained by the Rhine, and allowing 60 per cent. for evaporation and absorption, it appears that the delivery of the river should be about 560 cubic metres per second,—a computation which agrees very well with gaugings made between Waldshut and Bâle, after the junction of the Aar, which brings in the waters of the Reuss and the Limmat.

Taking the normal flow of the river at the points where its utilisation is possible, the following table, condensed from one in the article referred to, shows the net power available on the turbine shafts at each point :

1.	Falls of the Rhine (Laufen).	10,600 h. p.
2.	Rheinau	6,500 "
3.	Eglisau	8,000 "
4.	Kaiserstuhl (Weiach)	5,500 "
5.	Laufenburg	12,000 "
6.	Rheinfelden	15,700 "
7.	Aeugst	10,000 "
	Total	58,000 h. p.

At present about one-half of the power is already utilised at the Falls of the Rhine at Laufen, while at Rheinfelden the entire capacity of the river will be used by the great power station now nearing completion. The energy developed by the proposed station at Aeugst is to be taken entirely in the city of Bâle.

Laufenburg is less favourably situated with regard to the supply of a large city, but, within reach of electrical transmission, there are a number of minor industrial centres which can be well supplied from this power station, although this plant is a matter for the future.

The present sources of power available for development by the cantonal government are those at Rheinau, at Eglisau, and at Weiach near Kaiserstuhl, in addition to the remaining half at the Falls of the Rhine. Where the river forms the boundary between two cantons, the power must be divided equally between them, the Falls of the Rhine and Eglisau being controlled by Zurich and Schaffhausen, while at Rheinau and at Weiach the power belongs to the canton of Zurich and to the Grand Duchy of Baden, and at Laufenburg and at Aeugst it is divided between the canton of Aargau and the Grand Duchy of Baden.

The manner in which the power is to be developed at these various stations is briefly indicated, and gives some idea of the extensive engineering works involved. At Laufen a tunnel is to be pierced through the rocks on the left bank of the Rhine above the falls, rendering the entire fall of 23 metres available; and, as the minimum discharge is 23 cubic metres per second, this will give, at an efficiency of 75 per cent., a net capacity of 5,300 h. p.

Below the falls at Laufen the river follows a winding course, without sufficient fall to enable any direct utilisation of its power, but, by the construction of a dam, and the boring of a tunnel to carry the water across a loop in the stream, a head of 7 metres can be obtained, which will enable 6,500 h. p. to be utilised at Rheinau, and at the same time leave a flow of 15 cubic metres per second to keep up a semblance of water in the Rhine between the intake and discharge of the tunnel.

At Eglisau and at Weiach dams are to be built, furnishing a fall of 7 metres at the former point and 4.50 metres at the latter, and an aggregate of 13,500 h. p. at the two stations. Each station is to be provided with a reserve of steam power to make up any deficiency in power which may arise in time of low water, it being estimated that about 25,000 h. p. of steam machinery will be installed for occasional use on this account.

Details of the electrical portion of the scheme are not given, but it is intended that a three-phase current at a pressure of 10,000 volts shall be used, being distributed to main centres and transformed to 3,000 volts, and then again distributed to local stations, at which a second reduction to 300 volts will be made, and the current delivered to the consumers.

The price which is to be charged for power varies according to the magnitude of unit, ranging from 500 francs per year for a single horse power to 160 francs per h. p. for 100 h. p., being about one-half the cost of steam power, based on the price of coal at Zurich or Winterthur.

If this important project is carried to a successful completion, it will afford a notable example of governmental development of natural resources, and also a remarkable illustration of the entire utilisation of an important river for power purposes over a stretch of more than one hundred and thirty miles.

Bridging the Rhine at Bonn.

DURING the past few years Germany has been especially active in the construction of important bridges, and in these columns notice has been given from time to time of the projecting and completion of important structures such as those at Düsseldorf, Müngsten, Worms, and Bonn.

The latter bridge, but recently finished, is an excellent example of a type of which the Düsseldorf bridge is also an illustration, consisting of a braced arch span of much greater rise than the roadway level, the latter being formed of a light truss suspended by rods from the ribs of the great arch above.

In the Düsseldorf bridge, the completion of which was noticed in these columns last month, there are two of these wide spans, each of 594 feet, while in the new bridge at Bonn, of which an excellently-illustrated account appears in the *Deutsche Bauzeitung*, there are one main central span of 614 feet, and two side spans of just half the width, or 307 feet each, together with a number of smaller masonry arches to form the approaches of each side.

This form of construction involved two main piers in the stream, and, fortunately for the conduct of the work, the conditions were favourable for satisfactory foundations. Beneath the river mud was found a bed of sand and gravel containing coarse pebbles, the whole forming a layer more than forty feet thick, under which was found a solid bed of clay. This enabled the foundations for the piers readily to be constructed of concrete within coffer-dams, the coffer-dams being formed upon rolled-steel sections, which were driven through the gravel and sand until the clay was reached, and then filled with concrete. The concrete was made with Portland cement, to which trass was added, in order to hasten the setting.

When the foundations were completed, the vertical steel members of the coffer dam were cut off below the water-line. This difficult operation was performed by the use of electric drills, holes being drilled close enough together to enable a definite fracture to be made.

The general construction of the superstructure, which was executed by the Gutehoffnungshütte, calls for no especial comment, but it is interesting to note that electric power was used wherever possible, a temporary electric power plant being set up, and electric cranes and other applications of electric power being installed.

As at Düsseldorf, the general computations and proportions of the arches were under the charge of Professor Krohn, of Sterkrade, while the somewhat elaborate ornamentations of the railings and portals were due to the architect, Bruno Mohring, of Berlin.

Germany now possesses two important and interesting structures in these new Rhine bridges, and it is more than probable that similar designs will be adopted for wide-span bridges at other points where the low grade will not permit the use of the more desirable high-level arch.

The Refrigerating Plant of the Vienna Markets.

IT has been asserted that the most important invention of man is that of artificial light, doubling the possible length of the operative day; close upon this in importance, however, must be classed those inventions which give us control of temperature by production of heat and cold. There is every probability that in the immediate future much of the effort of human energy will be directed toward equalising the variations of natural forces, one result of which will doubtless be the general introduction of artificial cooling for many purposes to which it is not now applied.

In a recent issue of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* is given an illustrated account of the interesting plant installed in the great market buildings at Vienna, which, though there are other and as important plants elsewhere, possesses features that render it worthy of notice.

As the plant is intended merely to maintain a low temperature without reaching the freezing-point, thus providing storage rooms cool enough to insure the proper preservation of meats and other market articles, and at the same time avoiding the objections of too low a temperature, the indirect system is adopted, cooled air being distributed through the storage chambers by a forced circulation.

The refrigerating machines used in this especial case operate with carbonic acid gas, the gas being compressed to liquefac-

tion and the heat of compression removed by water, after which the liquefied carbonic acid is permitted to expand again to the gaseous state in coils placed in tanks of brine, the brine thus being lowered to the desired temperature, while the expanded gas is returned to the compressors to complete the cycle. It is evident that any of the accepted forms of refrigerating machines might be used in this manner, the choice depending upon local conditions.

The cold brine, instead of being circulated through coils of pipe in the storage chambers, is permitted to flow over a series of pans or trays arranged in layers in a special chamber, and the air is drawn through the spaces between the trays and thus cooled before being delivered to the storage vaults. The circulating fan, placed at one end of the chamber in which the cooling trays stand, draws the air from the storage rooms through the spaces between the trays and delivers it again into the vaults, the same air thus circulating continuously, in a direction opposite to that of the cold brine over the trays.

The effectiveness of this method of cooling for the maintenance of a moderately low temperature, without permitting the freezing-point to be reached, is well shown in a graphical record giving the maximum and minimum external temperatures for the entire year from April, 1897, to April, 1898, together with the corresponding slight variation which took place in the storage vaults. A temperature from 1° to 5° C. was maintained with a remarkable degree of steadiness during a period in which the external temperature varied between +35° and —5° C.,—a result so very satisfactory that the system is to be extended to additional market storage vaults in Vienna.

The original paper, which is from the pen of Herr Joh. Hermanek, gives in tabulated form some valuable data concerning the performance and efficiency of this plant, and many points of value which cannot be detailed here are described and illustrated at length, making the whole a valuable contribution to this branch of engineering.

Electric Tramways in Germany.

THE *Elektrotechnische Zeitschrift*, gives, as is usual at the beginning of the year, a review of the growth of electric tramways in Germany, and this exposition of the growth of electric traction in the German empire during 1898 shows that the rate of progress of the past few years has been fairly well maintained. The tabulated statistics bring the precise data only to September, but, as this was also the date for previous years, the comparison can be made, and the amount of completed construction at the close of the year can be estimated very closely.

Among other interesting facts it is shown that on September 1, 1898, there were 68 cities in Germany in which electric tramways were in use, as against 56 in the previous year,—an increase of more than 21 per cent.; but this is not so correct a measure of the progress of the work as is obtained from some of the other figures, the total mileage having been nearly doubled (49.4 per cent.), the number of motor cars having been increased by 41.5 per cent., and the capacity of the power stations being 33 per cent. greater in 1898 than in 1897. Taking into account the works in progress, there are 77 cities in Germany in which electric traction is in operation, with a total mileage of 963 miles, or, measured as all single track, 1,250 miles.

Among the larger cities may be noted Aachen, Braunschweig, Chemnitz, Dresden, Hamburg, Hanover, Leipzig, Munich, Stettin, and Stuttgart, all of which are rapidly becoming filled with complete tramway systems covering practically their entire area; while in Berlin, Breslau, Cassel, Köln, Frankfurt, and Konigsberg, the conversion of horse tramways to roads operated by electric power is rapidly going forward.

The total capacity of the dynamos used for electric traction in Germany is now 33,333 kilowatts, not including storage batteries equivalent to 5,118 kilowatts, thus giving a total of 38,451 kilowatts. Taking the data of 44 tramways, the average powering per kilometre is 20.7 kilowatts, or 33.3 kilowatts per mile, while for

the same roads the powering per car averages 14.2 kilowatts.

Nearly all the tramway systems operating in Germany use the overhead trolley, the only underground conduits being on short lines in Berlin and Dresden. In some cities the so-called mixed system, using overhead conductors in connection with accumulators, has come into use, especially in large cities in which the overhead trolley is objectionable in certain portions. Such combinations are in use in Berlin, Dresden, Hagen, and Hanover, while in seven cases pure accumulator traction is used.

The data concerning the various electric tramways in Germany are tabulated with German thoroughness in the article referred to, and a study of the tables will furnish valuable material for the prosecution of other installations. The tables contain information as to the grades, length and gauge of tracks, and number of motors and their capacity, together with a quantity of miscellaneous data concerning the power plants, and other useful information.

While Germany has undoubtedly done well in increasing her electric tramway mileage from 600 to more than 1,200 miles in one year, she is yet far from being fully equipped with local electric transportation facilities.

In comparison with the United States, with their 15,672 miles of track, the work which has yet been done in Germany is only a beginning, the total tramway mileage in Germany being somewhat less than that now in operation in the state of Ohio alone.

In view of what remains to be done, not only in Germany, but in other parts of the continent, as well as in England, the published data of existing tramways should serve only as incentives to engineers and electricians to push forward and develop a field which is so important, and as yet so far from being occupied.

Colliery Explosions.

A VERY interesting question has been brought forward by the disastrous explosion in the Carolinenglück mines (Westphalia), where 120 men perished, the greater number of them asphyxiated at points as far as 1,000 metres from the focus of the explosion. In the *Revue Universelle des Mines*, Herr Franz Büttgenbach, discussing the explosion, which was due to suspended coal-dust, suggests that the ventilation of mines may be too energetic, and that the forcing of volumes of air into the workings after such an explosion may simply mean the carrying of the deadly carbonic oxide, remaining as a product of the actual explosion, to remote workings.

In the disaster referred to, the men who were killed were at great distances from the scene of the explosion, and their bodies bore no marks of mechanical injury. The energetic ventilation of the mine seems to have thoroughly spread the gaseous products of combustion, the more readily because the shock of the explosion had destroyed the partitions and doors in the mine which served to direct the currents of air. In less than ten minutes the workings were full of air charged heavily with carbonic oxide, the result being the appalling fatality noted above.

Another point urged by the author is that the strong currents of air due to a too-powerful ventilation dry the dust of the mine, especially that lodged in the upper parts of the galleries and on the timbering, and that no amount of sprinkling will reach that. There is thus maintained a fruitful source of danger. While it is admitted that forcible ventilation is the best means of ridding the workings of firedamp and floating dust, it is equally certain that the ill effects of drying the deposited dust and spreading the gaseous products of a localised explosion may fully counterbalance all the merits of energetic circulation of air.

THE AMERICAN PRESS

Review of Leading Articles

The Civil Engineer and Public Health.

THE close relations existing between the occurrences of daily life and the work of applied science are becoming more and more generally appreciated, and in no branch of engineering science is this relation more apparent than in the department of sanitation.

In an address, lately delivered before the Engineers Club of St. Louis, and published in the *Journal of the Association of Engineering Societies*, Professor J. B. Johnson discussed the subject of the civil engineer as a guardian of public health, and outlined this important relation of a large portion of the profession to the public in a very interesting manner.

The fundamental care of health, in so far as it consists in the fighting of disease, is undoubtedly the function of the physician, but when the question of prevention is considered, the work of the engineer must be the main reliance of the community.

The growth of the science of bacteriology, which may be said to have commenced with the introduction of vaccination by Jenner, in 1798, has demonstrated that all infectious or contagious diseases are caused by taking into the system either in the air we breathe, in the water we drink, or in the food we eat, pathogenic, or disease-producing, bacteria.

"As soon as this is admitted it becomes somebody's duty to look well to the elimination of these ailments by preventing their causes from reaching their natural prey. On reflection it will be found that the carrying out of these preventive measures devolves largely upon the civil engineer, and furthermore, he is called upon to determine what measures will prove at once most economical and most effective in preventing the spread of these fatal maladies."

Notwithstanding the important relation which the engineer thus bears to the vital question of public health, there is evidently insufficient interest taken in the subject by a large proportion of the profession. It is this point which is especially emphasized by Professor Johnson, and, holding as he does, that the provision of the means of prevention of disease falls within the sphere of duties of the civil engineer he maintains that it is the further duty of the engineer "to inform himself thoroughly as to all the causes and remedies and to lead in the work of educating the public to the point of providing legislation and funds to carry out such measures and to build such works as are required."

Professor Johnson calls attention to the fact that less than 3 per cent. of the membership of the American Public Health Association is composed of engineers, practically all the rest being physicians, while we should expect to see an association devoted to the prevention of disease mainly composed of bacteriologists and sanitary engineers rather than of physicians. It is greatly to the credit of the medical profession and to the discredit of the engineering profession that the reverse is the case.

It is solely the engineer's business to provide the drinking water, to dispose of all sewage and garbage wastes, to make healthful streets and alleys, and to keep them clean. The business of heating, lighting, and ventilating large assembly halls, hospitals, school buildings, and railway stations and cars is also now coming to be regarded as the business of engineers, and soon the artificial cooling of such buildings will be added to their duties. The census reports show that one death in every seven is caused either by a diarrheal disease or by typhoid, malarial, or intermittent fevers, and nearly all these deaths are known to be caused by impure drinking water. In the year 1890 over 120,000 persons died in the United States of these diseases, and without doubt we may charge this number of deaths to the use of impure water.

According to the laws of many states, the value of a life is placed at $5000, thus making the money value of the lives thus unnecessarily sacrificed equal to more than $6,000,000 annually, and, as Professor Johnson points out, it would cost very much less than this amount to provide preventive means against such loss.

The means of preventing the spread of disease through drinking water is a rational or scientific filtration, such as has now been shown to be effective. The means of prevention of disease from the decay of organic matter caused by bacterial parasites is to remove immediately all organic wastes from the confines of the city. The rapid and thorough removal of street accumulations means a smooth, clean, and impervious pavement, and the wooden pavement so common in many large cities is most unsanitary so soon as it has begun to decay. Again, the elementary and fundamental principle of sewerage is not only to move all filth off as quickly as possible, but when it is started it should be kept moving until it passes into some large river or goes to some kind of purifying terminus. The relations of sources of water supply to methods of sewage disposal should also be considered in this connection, so that in all these problems, so vitally connected with the prevention of disease and the guardianship of public health the engineer stands before the physician, and if the former knows what to do, and is given means and opportunity for doing it, the latter would be far less busy in curing diseases which should not have been permitted to exist.

The New South Terminal at Boston.

THE new South Union Railway Station, of the Boston Terminal Company, which has just been opened, is much the largest railway station in the world, having about double the capacity of any other. Descriptions of it have been published in several of the American railway and engineering journals.

The Railroad Gazette says: "Entering at the main entrance, at the corner of Cove and Summer streets, we pass at once, without steps and with an imperceptible rise of about 3 feet in 100, into the great 'midway' lying across the ends of the stub tracks. . . . The surface stub tracks, twenty-eight in number, and at a grade of five feet above the sidewalk outside, are arranged in pairs, with a passenger platform to each pair, and between the pairs are seven platforms devoted exclusively to the trucking of baggage and express matter, which serve fourteen tracks and are reached by electric truck-lifts from a subway under the tracks leading from the baggage-room. The train shed is in three spans, with a roof of one sweep."

The total frontage of the building on three streets is 2,190 feet, the main front being 875 feet long and five stories high. The entrance is a thoroughfare 92 feet wide, lined with polished granite. Its ceiling is of white enameled bricks, with steel girders encased in white marble. The outward baggage-room is 26 feet wide and 562 feet long. Opening towards the "midway" are eleven ticket-windows while sixteen more open into the waiting-room, affording ample facilities for the booking of passengers.

The immense waiting-room, 225 feet long, 65 feet wide, and nearly 30 feet high, is a feature of the design of the station. The women's waiting-room is 34 by 44 feet, and is provided with lounges, and even with cradles for children.

The power and other engineering equipments of the station are on the same elaborate scale. Among them are provisions for heating and lighting, ice-making, air-compressing, water-filtering and cooling, fire-protection, pumping, and for preventing the freezing of the leaders which carry away water from the immense roof and train-shed areas. All the switches and signals about the station are operated by compressed air. Some of the signals are located on the ground, but most of them are on nine signal-bridges, varying in span from 50 to 120 feet. On the easterly side of the yard is a building, 460 by 40 feet, which contains the power plant for all services. No less than nineteen electric elevators are in the buildings.

The provisions for heating and venti-

lating are on a scale commensurate with other features of the building, nearly 5,000,000 cubic feet of space being enclosed. Air is forced in by electrically propelled fans in the cellars and driven out by similar exhaust fans in the attics. All the lavatory ventilating system is distinct from that for other parts of the building. The ice-making plant has a capacity of twenty tons per day.

Special precautions were necessary for the disposal of water, as all the suburban loop-tracks, and a number of the basements, are below tide-level. A large sump was built near the power house, into which the whole of the track surfaces, etc., are drained, and from which a centrifugal pump removes the water. As there are some fourteen acres of roofs from which storm-water and melting ice and snow are to be carried away by many conductors, the prevention of the freezing of the latter was a problem of the first order. It has been solved by special provisions for the application to them of steam and hot water.

At the old stations which are to be consolidated in this new structure there have been about 4,000 train movements in 18 hours of each day. It is believed that the arrangement of tracks at the new station is simple, and ample for this purpose.

Some further dimensions may be of interest, as showing the great size of this important station. The main building is 850 by 725 feet in plan and 135 feet high. The train-shed is 602 feet long and 570 feet wide, having three spans, of which the central one is 228 feet. About 2,500 tons of rails are used in the fifteen miles of tracks comprised in the terminal. Four miles of these tracks are under roofs.

The Regulation of the Mississippi.

THE report of the U. S. Senate Committee on Commerce upon the subject of the regulation of the Mississippi river, of which a very full abstract is given in the *Engineering Record*, contains much interesting matter about the floods in the great river, and the means which are being taken for its control and regulation.

The regulation of the Mississippi has two great ends in view; one, the prevention of damage from the overflow of low-lying country at certain points along its course, the other, the improvement of its navigation by providing a channel of sufficient depth for the draught of such vessels as the demands of commerce may require.

The principal territory affected by floods consists of certain basis or bottoms along the banks of the river between Cairo and Forts Jackson and St. Philip, there being six of these basins, with an aggregate area of 29,790 square miles.

Ever since the settlement of these portions of the valley of the river there has been a constant struggle to reclaim these basins, but the work is as yet only partially accomplished.

The floods which cause the overflow of these basins are due to a combination of causes, the principal source being the Ohio river, from which the spring floods from the crest of the Alleghanies bring a great volume of water at a time when the normal rise of the lower Mississippi brings the river almost to the danger line. With this is combined the heavy rainfall over the swamp region along the Mississippi from the mouth of the Ohio to the Gulf of Mexico, as well as the later rise of the upper Mississippi, which serves to prolong the floods.

The upper portion of the river is measurably controlled by reservoirs, but neither on the Ohio nor on the lower Mississippi are there suitable locations for reservoirs, and it appears that the cost of this method of regulating the river would be far greater than the construction of embankments, or levees along the entire front of the basins.

Levees have been constructed along the river at various points ever since 1717, and the history of the river from that time has been a record of construction and breaks, with many floods and the incurring of much damage. The construction of the levees has gradually extended, having been undertaken by riparian owners, then by parishes or counties, then under the authority of states, and finally by the general government, and although the work which has been done by the states and the

general government has been conducted in an entirely harmonious manner, yet it is evident that the river cannot be properly and entirely controlled, so far as floods are concerned until an entire system of levees constructed as a whole by the general government is executed.

It is estimated that such a system, from the head of the St. Francis Basin to the Head of the Passes, at a grade sufficiently high and strong to afford complete protection against floods at the highest probable stages, would cost from $18,000,000 to $20,000,000, and that it would take four to five years for its completion. Such a system is recommended in the report, and the saving of life and property which it would cause, seems an ample warrant for its construction.

So far as navigation is concerned, the chief reliance for obtaining a low water navigable channel seems to be dredging, and with the improved hydraulic dredges, excellent results have been obtained. At the passes, forming outlets into the Gulf, jetties, dykes, and dams have proved effective, and these supplemented by dredging have given the best results at least cost.

There seems to be little doubt that the recommendations of the Senate committee, based as they are upon the experience of the engineers who have been fighting the great river through some of its most disastrous floods, should be carried out with energy and unity of purpose, and that sporadic and local attempts should give way to a determined effort to execute a complete and systematic plan for the regulation of the stream from the mouth of the Ohio to the Gulf of Mexico.

Street-Railway Mileage and Capitalization in the United States.

No industry is more peculiarly American than the electric street railway. The prodigious and astonishing growth of this industry since its beginning, eleven years ago, to the present, and the rate at which it is now increasing, are both well shown in an elaborate tabulated statement published in the *Street Railway Journal*.

The total mileage of street railways in the United States at the beginning of this year was 17,291, of which 15,672 miles were operated by electricity. During 1898 the increase in total mileage was 1,573 miles, while the increase in miles of electric railway tracks was 1,997,—the apparent discrepancy being due to the decreasing mileage of cable and horse railways. The percentage proportion of the various kinds of street-railway systems, estimated on a mileage basis, is as follows: electric, 90.6 per cent.; horse, 3.8 per cent.; cable, 2.9 per cent.; miscellaneous systems, 2.9 per cent. Comparing the mileages at the beginning and end of 1898, the electric systems show a growth of 12.2 per cent., the cable mileage has decreased 14.7 per cent., and the horse mileage has decreased 31 per cent., while miscellaneous systems, such as steam and oil motors, have increased their mileage 8.15 per cent.

These figures show the enormous preponderance of electric systems; but perhaps the most illuminating statistics are those relating to the capital investment in these traction enterprises. In the tables referred to there is no differentiation between electric and other systems as regards the capital represented, but the insignificant proportion invested in horse, cable, and other miscellaneous systems makes no great difference in the result. The increase of investment in 1898 amounted to the enormous total of $142,610,025, while the grand total of capitalization reaches the amazing figure of $1,621,820,894. No less than 54,529 cars are in circulation upon the tracks of the various systems. Of the fifty States and territories seven have no street railways. Of the forty-three possessing tramway systems ten—New Hampshire, Vermont, Rhode Island, Connecticut, Delaware, Maryland, Michigan, Idaho, and Utah—have no horse-car lines.

On another page is a review of a recently-published table of similar statistics relating to the German empire, in which it is stated that there are in operation in that country 1,250 miles of electric-railway lines. Five of the States surpass this figure,—Massachusetts, New York, Pennsylvania, Ohio, and Illinois,—New York alone having 1,862 miles in operation.

A Gigantic Power Plant.

THE central power plant for the Third Avenue Railroad Company's lines in New York will be the largest single aggregation of electric power-generating machinery ever constructed. A recent number of the *Electrical Engineer* contains a preliminary account of this last and largest enterprise in electric traction.

The generating units will be sixteen in number, each consisting of an engine of 4,000 h. p., economic rating, direct-coupled to a polyphase-current dynamo of 3,000 kilowatts' capacity. This will give the station a nominal capacity of 64,000 h. p., or a maximum capacity of about 100,000 h. p. The engine room will be 320 feet long. In the adjacent boiler house the 30,000 h. p. of water-tube boilers will be arranged in two rows on each of two stories, while over all a great coal-bin will be erected. From this bin the coal will be fed directly by chutes into automatic stoking-machines. Ashes will be automatically withdrawn from below the boilers. Both natural and forced draft will be used in connection with four tall steel stacks. All the condensing apparatus will be concentrated into a central plant, by which the engines will be served in sections. Most elaborate provisions have been made for handling this part of the plant with economy and reliability.

A separate isolated plant will supply electric light to the building and adjoining premises, while provisions have also been made for fire protection, a cooling system, oiling system, coal- and ash-conveyors, and the other numerous appurtenances of so large a project. About one hundred miles of track, some of it among the busiest in the city, will be served from this station, while a part of its surplus energy will be used for the charging of the accumulator omnibuses, which the company expects to introduce in Fifth avenue.

There will be some very interesting questions in connection with the operation of this enormous plant. Probably there has been no attempt before to work such a number of polyphase generators—certainly not those driven by steam-engines—in parallel. If this cannot be accomplished successfully, as some engineers believe, the advantages of consolidating this great mass of generating machinery under one roof are, for the most part, lost. A fuller description of the plant, with details of the methods for engine-governing, will be of great interest, for the project appears to have been well studied in its details. The sub-station system will be used for the conversion of the polyphase current into that needed for the propulsion of the cars, but no details regarding the methods to be employed have been given out. The necessity for paralleling the direct-current sides of these also introduces some rather difficult problems, especially if rotary converters are to be used.

Electric Vehicles and Central Stations.

THE rapid advance of the electric automobile introduces a new element for the consideration of those interested in electricity supply stations, on account of the almost immediate possibility of these vehicles offering a remunerative day-load. The problem of securing a day-load for such stations has been long considered, and its solution is most desirable from the station manager's point of view, because the equipment of the generating plant must be sufficient to carry its maximum load,—coming on only for a few hours each day,—while, during the rest of the time, the machinery needed to provide for the maximum demand is idle. Interest and depreciation costs are never idle, however, and mount up as rapidly while the machinery is standing still as when it is running.

In a paper read before the Northwestern Electrical Association, at Milwaukee, Mr. H. M. Maxim gives the results of investigations undertaken to discover the probable future usefulness of these vehicles as a source of demand for electrical energy. He discusses the cases of delivery-wagons, such as are used by large retail establishments, and of omnibuses and cabs. While the wagons of a single large concern are apt to be sent out according to a definite schedule, thus causing the demand for power for charging to fall between certain

definite hours, this would not be the case with vehicles from a number of smaller establishments,—the class of custom most likely to be found in practice. In the operation of cabs and omnibuses the demand for power can be so regulated as to furnish an almost ideal day-load. Taking the case of a recently designed omnibus system, having nine vehicles running under a headway of five minutes, Mr. Maxim shows that the power-demand would be constant between narrow limits,—880 and 930 amperes,—and that such a system would be an admirable customer for an electricity supply station.

"The demand for omnibus service in many places, especially in certain regions where, for æsthetic reasons, the trolley line is excluded, is without doubt a real one, and will, within the next twelve months, call for the equipment of many such lines. Their success in many instances must rest, in a measure, upon the coöperation which the central-station owners afford, and it would seem that the desirability of increasing the day consumption of power, and the ultimate immensity of this demand, would invite their most favorable attention. The consumption of day-loads by electric vehicles offers such manifest advantages that the lowest possible rate should be made this class of of customers for the encouragement of the industry and from considerations of its coming importance."

Sand Filtration.

THE question of pure water supply is one which must be met by every municipality, and unless the locality is so exceptional as to have a natural supply of uncontaminated water, some artificial means must be adopted, either to bring pure water from a distance or to purify that which is nearer at hand.

In a paper by Mr. R. S. Lea, recently presented before the Canadian Society of Civil Engineers, upon the purification of public water supplies by sand filtration, the more recent installations of this method of purifying water are described at length, and much useful information is given.

That some such method of obtaining a pure water supply must ultimately be adopted in the great majority of cases is daily becoming more apparent. No matter how pure the source may have been when first utilized, and no matter how far it may originally have been situated from causes of contamination, it is practically impossible to maintain the condition by which alone purity is secured. Even could contamination be prevented, the increasing demand for pure water by rapidly growing cities constantly involves the development of additional supplies and these are naturally increasingly difficult to obtain.

Pure water is naturally preferable to purified water but "water whose natural state is above suspicion is often exceedingly difficult to procure except at a cost which is practically prohibitive. Consequently many cities and towns, especially the larger ones, are forced to use such waters as may be practically available, and to make the best of them."

"This best is by no means to be held lightly, since by modern methods of sand filtration it is possible to so change the nature and characteristics of polluted water as to convert it to the appearance, taste, and probably absolute wholesomeness of the most innocent of mountain torrents."

Water supply may be derived either from ground waters or from surface waters, the former being subjected to such a rigorous process of natural purification as to place them beyond the need of any artificial treatment, while the latter are nearly always polluted to a greater or less extent. The nature of the pollution may be that unavoidable in any stream, such as discoloration by swamp drainage, turbidity from clay and other suspended inorganic-matter, or development of algæ and other minute water plants, or it may be the far more dangerous pollution due to the reception of human sewage.

These questions should in every case be determined by thorough chemical and biological examinations before any attempts are made to devise systems of purification, always bearing in mind that it is in connection with the organic matter

in water, dissolved or suspended, visible or invisible, that serious pollution from a sanitary standpoint is to be apprehended.

Assuming the presence of organic matter of an objectionable character, the method of purification must be considered, and it is to this portion of the problem that the greater part of Mr. Lea's paper is devoted.

When the first attempts at water purification were made, very little was known of the organic matter in solution, and the object aimed at was simply the clarification of the water, or the removal of suspended matter visible to the eye. It was for this purpose that the first sand filter was constructed by Simpson, in London, in 1839, the water being passed through a layer of about six feet of sand and gravel, the result being very satisfactory. With such filters it was found that the surface of the sand became gradually obstructed by the formation of a layer composed of the material removed from the water, and when the water failed to pass the filter it became necessary to remove the deposit.

When the development of the science of bacteriology demonstrated that it was to the presence of certain of these microscopic organisms that dangerous pollution of water was due, it was at first supposed that filtration would be powerless to remove them.

"How," it was asked, "can filtration affect substances dissolved in water? And as for the minute organisms found in putrescent bodies, they could pass a hundred or a thousand abreast through the interstitial spaces of ordinary sand as used for this purpose." Nevertheless it was found that the sand filter did remove 97 to 98 per cent. of all the germs contained in the water, and, with the modifications and improvements made over the earlier forms, it can now be depended upon to remove from 99 to 100 per cent. of the germs.

While there is even yet some difference of opinion as to the precise *rationale* of the efficiency of the sand filter, there is no doubt that it is due to the formation of an organic layer or mantle of a jelly-like nature on the surface of the sand, together with the deposit of a coating of the sand grains with a film of the same gelatinous organic material for a considerable depth below the surface.

Details of the construction of numerous installations of sand filters, both in the United States or Europe are given by Mr. Lea, and the results of experience, as most fully exhibited, demonstrate the entire practicability, both from a scientific and a commercial standpoint, of this method of obtaining a pure water supply from any available stream or lake.

"If a proper valuation is put upon the lives saved by its use, the construction of a filter plant is often in the long run a source of economy. Such considerations, however, seem quite unnecessary. A city water supply should be pure, wholesome, attractive in appearance, just as the streets should be clean and well paved, and the public buildings architecturally beautiful. Besides, having gone to the expense of obtaining a public water supply, indifference with regard to its purity, or unwillingness to provide for it would seem to be utterly unreasonable, especially when it can be secured for such a comparatively small increase in the total cost as sand filtration involves."

Train Resistance.

NUMEROUS attempts have been made to devise a formula from which the resistance of a railway train may be computed when the speed and weight are given, but the problem has been found almost as elusive as the not dissimilar one of the derivation of a formula for the velocity of the flow of water.

In a recent issue of the *Street Railway Journal*, is given the latest effort to solve the problem of train resistance, and a formula, derived by Mr. John Lundie using a new method of investigation, is given together with a table of comparisons with the results of actual tests, showing the degree of accuracy which may be expected from its application.

The method hitherto followed for finding train resistance has been that of computing from indicator cards the power developed by the locomotive when draw-

ing a train at a constant speed over a level track; with an arbitrary allowance for engine friction. The difficulty of finding long distances of straight track, and of maintaining uniform speed has made this method unsatisfactory, and hence Mr. Lundie has attacked the problem in another manner.

Instead of measuring the resistance directly from the power required to haul the train, he determines it by an examination of the speed curves of a train when coasting from any speed to a dead stop. By adopting this method it is possible not only to obtain the gross resistance due to track and journal friction and air resistance combined, but also to differentiate between the air and the friction elements.

By taking the results from more than 150 runs made with trains of different weights on the South Side Elevated Railroad of Chicago, points were plotted in a graphic form, and it appears that these points cluster closely around "straight-line curves" and also that these lines intercept each other at a single point situated at a definite distance above the origin.

From this it is to be seen that the resistance should be expressed by an equation of the first degree, the location of the point common to all the lines giving the minimum possible train resistance for all speeds and weights. This minimum resistance appears, by Mr. Lundie's diagram to be four pounds per ton, and it is interesting to note that in none of the recorded experiments so far made on passenger or freight trains of all weights, has the resistance been less than this figure.

Mr. Lundie's formula is as follows:

$$R = 4 + S\left(0.2 + \frac{14}{35 + T}\right)$$

in which

R = resistance in pounds per ton.

S = speed in miles per hour.

T = the weight of the transportation unit in tons (2000 lbs.).

While this formula is empirical in so far that it has been deduced from the results of experiment, yet it is rational in form and in the manner of its deduction, and appears to rest upon a sound mathematical basis.

It is well said that the test of any formula lies in its application, and Mr. Lundie's formula appears to check very well with the Stroudley, Sinclair, and Dudley tests of train resistance as collated by the late Mr. Wellington, as well as with later experiments made on the Philadelphia and Reading Railroad and on the Central Railroad of New Jersey. Since the tests from which the formula was deduced were all made upon trains of 20 to 100 tons, and for speeds from five to thirty miles per hour it is very satisfactory to find that it agrees within about 5 per cent. for trains of 100 to 300 tons and for speeds up to 70 miles per hour.

The Franklin Institute.

THE completion of the seventy-fifth year of the existence of the Franklin Institute renders a brief notice of the work of this important scientific institution timely, especially as its true position is often misunderstood by those not familiar with its purposes and workings.

Both in its regular meetings and in the meetings of the various sections of specialists, the Franklin Institute affords opportunity for the presentation of subjects in nearly every line of scientific research, with the assurance that intelligent and exhaustive discussion will be given and the results of experience elicited.

When any subject is deemed worthy of elaborate investigation and report it is referred to a sub-committee chosen from such members as may be deemed especially qualified to examine it, and in this manner very many inventions, processes, and suggestions have been given exhaustive study at the hands of experts whose services might not otherwise be available.

The Franklin Institute also renders an important incentive to investigators by the award of medals and premiums for meritorious work in various lines of research and invention, being in this respect not unlike the French *Soeiété pour l'Encouragement de l'Industrie Nationale*, and the awards of the various medals in the control of the Institute are eagerly sought by inventors in all lines of industry.

THE ENGINEERING INDEX

INTRODUCTORY

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10c. per month, or $1.00 a year; to non-subscribers, 25c. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m* a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. della Societa d. Ing. e d. Arch. Ital. Rome. *b-m.*
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am. Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R
Colliery Guardian. *w.* London.
Commerce. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, New York.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *w.* Chicago, Ill.

Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Political Economy. *qr.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w* Paris
Locomotive. *m* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, O.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *qr.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Publicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines, *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Düsseldorf.
State's Duty. *m.* St Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Terrestrial Magnetism. *qr.* Cincinnati, O.
The House Beautiful. *m.* Chicago, Ill.
The Mechanical Engineer. *w.* Manchester.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club. Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Locomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a..S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Cathedral.

The Cathedral of Troja. William H. Goodyear. Illustrates and describes very interesting details. 4200 w. Arch Rec—Jan.-March, 1899. No. 25520 C.

Churches.

Elements of Church Architecture. Part first considers the origin of the Christian churches. Ill. 700 w. Ill Car & Build—Jan. 6, 1899. Serial. 1st part. No. 25295 A.

Colonial Architecture.

Good and Bad Colonial Architecture. Clarence H. Blackall. Critical review of examples of this class of architecture of both early and recent types. Ill. 4000 w. Arch Rev—Vol. VI, No. 1—Jan., 1899. No. 25360 D.

Competition.

The Pennsylvania State Capitol. A brief history of the competition to furnish plans, its abolition, and the result. 1600 w. Eng Rec—Jan. 21, 1899. No. 25349.

Exposition.

Progress of Work on the Champs-Elysées Palace of the Exposition of 1900. (Le Grand Palais. Chantiers de Construction.) A. da Cunha. Illustrated description of methods of work on this building. 2000 w. La Nature—Dec. 3, 1898. No. 25400 B.

High Buildings.

The "Sky-Scraper" Up to Date. Montgomery Schuyler. A critical review of many prominent buildings in New York, with fine illustrations. 6300 w. Arch Rec—Jan.-March, 1899. No. 25519 C.

Hospital.

The Lady Dufferin Victoria Zenana Hospital, Calcutta. Plans and drawings with description. 1000 w. Ind Engng—Dec. 17, 1898. No. 25367 D.

The Loomis Sanitarium. Illustrated description of a hospital for consumptives. 600 w. Eng Rec—Jan. 14, 1899. No. 25239.

Hotels.

Hotel Design. T. Raffles Davison. Part first illustrates a New Forest hotel—the Crown Hotel of Lyndhurst. 2000 w. Brit Arch—Jan. 6, 1899. Serial. 1st part. No. 25300 A.

House Planning.

House-Planning from the Aesthetic Point of View. H. H. Statham. Read at meeting of the Archt. Assn., London. On the importance of symmetry and a clear plan in securing effect. A comprehensive paper, illustrated by examples. Also discussion. 13500 w. Builder—Jan. 14, 1899. No. 25517 A.

Metal Framework.

The Morton Building, New York City. Illustrated description of cast-iron column framing with novel connections for girders. 800 w. Eng Rec—Dec. 31, 1898. No. 24988.

Municipal Architecture.

Municipal Architecture in Boston. A statement of the results of the present plan of obtaining designs for civic buildings and the proposed amendments. 1000 w. Eng Rec—Jan. 14, 1899. No. 25232.

Opera Comique.

The New Opéra Comique, Paris. Brief description with illustration. 700 w. Builder—Jan. 7, 1899. No. 25315 A.

Palace.

The Rococo Palace of Wilhelmsthal. (Rococo-Schloss Wilhelmsthal.) With interior views and details of this rococo palace of the middle of the 18th century. 3500 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25489 D.

Restaurant.

The New Poodle Dog Restaurant Building. Illustrates and describes a newly erected building in San Francisco. 3000 w. Cal Arch't—Dec., 1898. No. 25019 C.

Spires.

Notes on the Theory of Cupola and Spire Construction. (Beitrag zur Theorie der Kuppel und Turmdächer.) R. Kohfahl. A discussion and criticism of the recent paper of Prof. Müller-Breslau on the same subject, with diagrams showing methods of resisting wind pressure. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 17, 1898. No. 25461 D.

Theatre.

The New Royal Theatre at Wiesbaden. (Das Neue Königlichen Theater in Wiesbaden.) With elevation, plans and section of this handsome theatre. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 6, 1899. No. 25478 B.

HEATING AND VENTILATION.

Church.

Ventilating and Heating of a Newark church. Illustrates and describes a system with some direct radiation, supplemented by a heated fresh air supply intended to furnish one-third the total heat. Circulation of air in the church is obtained in an unusual manner. 1400 w. Eng Rec—Dec. 31, 1898. No. 24990.

Disk Fans.

Some Formulas for Disk Fans. J. H. Kinealy. Paper presented at the New York meeting of the Am. Soc. of Heat & Ven. Engs. Formulas deduced by the writer for determining the proper number of revolutions, and the number of cubic feet of air a disk fan could be expected to deliver per minute. 1200 w. Eng News—Jan. 26, 1899. No. 25545.

Gas Warming.

Battery Gas Heaters. (Batterie-Gasöfen.) P. Schroeter. Describing improved forms of gas radiators for warming, including devices for control of temperature and for the removal of products of combustion; also data as to efficiency. 2500 w. Gesundheits Ingenieur—Dec. 31, 1898. No. 25485 B.

Heating Practice.

A Comparison of British and American Heating Practice. D. M. Nesbit. Compares the hot-water methods and the steam as practiced in Great Britain and in the United States. 4200 w. Dom Engng—Jan., 1899. No. 25501 C.

Residence.

Heating a Private Residence with a Warm-Air Furnace. B. Harold Carpenter. Condensed from a paper presented at the New York meeting of the Am. Soc. of Heat & Ven. Engs. Illustrates and describes arrangements for overcoming the weak points in warm-air furnaces. Discussion. 1100 w. Eng News—Jan. 26, 1899. No. 25549.

Heating a Residence. Describes and illustrates a combination system, providing for simultaneous heating by warm air and hot-water circulation. 1800 w. Met Work—Jan. 21, 1899. No. 25359.

School Heating.

Ventilation and Heating of the Melrose, Mass., High School. Illustrated description of a hot-blast system with the engine using steam at the same pressure (15 lbs.) employed in the coils. 2000 w. Eng Rec—Jan. 7, 1899. No. 25104.

Warehouse Heating.

Heating of the U. S. Appraisers' Warehouse. Illustrated description of a direct-radiation plant using the vacuum return system. 1500 w. Eng Rec—Jan. 21, 1899. No. 25358.

MISCELLANY.

Abbey.

Llanthony Priory. Historical description with illustrations. 3800 w. Builder—Jan. 7, 1899. No. 25316 A.

Architecture.

The Position of Architecture Among the Fine Arts. Report of the discussion on Edwin T. Hall's paper read before the Architectural Assn. 3000 w. Builder—Dec. 24, 1898. No. 25044 A.

Country Estates.

The Development of a Country Residence and Stable. Illustrated account of the water supply, sewage, lighting and stable accommodations. 2400 w. Eng Rec—Jan. 28, 1899. No. 25588.

Derrick.

An Extension Tower Derrick. Illustrated description of plant used satisfactorily on several high buildings in New York. 1200 w. Eng Rec—Jan. 7, 1899. No. 25102.

Dublin.

The Architecture of Our Large Provincial Towns. Historical and descriptive account with many fine illustrations. 14,500 w. Builder—Jan. 7, 1899. No. 25313 A.

Exposition.

Moving the 30-Metre Gallery of the Champ-de-Mars. (Déplacement de la Gallerie de 30 mètres au Champ-de-Mars.) Ch. Dantin. Illustrated description of the method used in moving the large steel framework of one of the old exposition buildings to a new site. 3000 w. Le Génie Civil—Dec. 17, 1898. No. 25409 D.

Fire Proof Construction.

Description of Fire Test of a Ten-Inch Hollow Flat Arch, Made by Maurer & Son, New Jersey. Gustav Liebau. The test was carried out on a building of brick erected for the purpose. Ill. 800 w. Brick—Jan., 1899. No. 25249.

Fireproof Construction of Buildings in the United States. R. W. Gibson. A discussion of the fire-resisting building methods in use in the United States, and the materials which have proved most satisfactory, with related matter of interest. Discussion. Ill. 11,700 w. Jour Roy Inst of Brit Archt's—Dec. 10, 1898. No. 25069 B.

The Tall Building Under the Test of Fire. H. de B. Parsons. A well illustrated paper dealing with the dangers of fire in high buildings, especially as exemplified in the case of the Home Life Insurance building in New York, and with the questions of so-called fire-proof construction and isolated fire-fighting plants. 4800 w. Engineering Magazine—Feb., 1899. No. 25438 B.

Fireproofing Wood.

See Military Engineering.

History.

Choisy's History of Architecture. R. S. Critical review of a recent work very favorable to the writer. 3500 w. Arch Rev—Vol. VII, No. 1—Jan., 1899. No. 25361 D.

Interiors.

Bricks and Tiles for Interior Finishing. Russell Sturgis. The article sets forth the sanitary and artistic possibilities of these materials, giving many suggestions for their use. Ill. 3000 w. Br Build—Jan., 1899. Serial. 1st part. No. 25606 C.

London Improvements.

The Proposed London Improvements. Text of the bill promoted by the London Council, which defines the nature and extent of the proposed improvements. 1800 w. Builder—Dec. 31, 1898. No. 25165 A.

Manchester, Eng.

Development of Manchester. E. Salomons. An address at a meeting under the auspices of the Manchester Soc. of Archts., on the development and suggested improvements. Brief discussion. 2400 w. Arch, Lond—Dec. 30, 1898. No. 25166 A.

Painting.

Sanitary Painting. A. G. White. An address delivered at the convention of the Master House Painters of England and Wales. On the sanitary, æsthetic and protective value. 2200 w. Jan. 6, 1899. No. 25312 A.

Roman Palace.

The Palace of the Cancelleria at Rome Not Designed by Bramante. Alfredo Melani. Considerations are presented based on examination of style, in part first. 1700 w. Am Arch—Jan. 21, 1899. Serial. 1st part. No. 25375.

CIVIL ENGINEERING.

BRIDGES.

Arch.

A Park Bridge. Illustrated description of a masonry arch in Central Park, New York, built under supervision of architects and an engineer. 400 w. Eng Rec—Jan. 21, 1899. No. 25351.

A Private Park Arch Bridge. Illustrated description of a concrete-steel bridge on the Vanderbilt estate, at Hyde Park, N. Y. 600 w. Eng Rec—Jan. 14, 1899. No. 25238.

The Theory and Design of the Masonry Arch. William H. Burr. A study of the stability of the arch, and methods of determining the pressures to which it is subjected. Diagrams. 6500 w. Sch of Mines Qr—Nov., 1898. No. 25197 D.

Bridge Failure.

The Cornwall Bridge Accident. A description of conditions before and after the accident, and an explanation of the cause. Ill. 1500 w. Eng News—Dec. 29, 1898. No. 24948.

The Wilson Avenue Bridge Disaster, Cleveland, O. An illustrated explanation of the cause and nature of the wreck of this bridge. 900 w. Eng News—Jan. 26, 1899. No. 25551.

Bridge Removal.

Rapid Bridge Moving. Presents further information concerning the bridge removal at Milwaukee. A 130-ton draw span was moved 219 ft. down the river to a new site, and located there ready for use in less than 3 hours. 700 w. Eng Rec—Jan. 21, 1899. No. 25355.

Removing a Bridge. Illustrates and describes the removal of a draw span over the Kinnickinnic river at Milwaukee, Wis., to a new site. 1000 w. Ry Age—Jan. 13, 1899. No. 25264.

Bridge Test.

Test of a Bridge to Destruction. An account of the test to destruction on a Vierendeel bridge in the Tervueren Park, on the occasion of the Brussels International Exhibition, held in 1897, and the conclusions drawn. The bridge was a type between a plate and lattice girder. Ill. 3300 w. Ry & Engng Rev—Jan. 7, 1899. No. 25179.

Drawbridges.

Some Interesting Types of Modern Drawbridges. Frank W. Skinner. Brief illustrated description of various types of drawbridges and their manner of operation. 2000 w. Harper's Wk—Jan. 28, 1899. No. 25518.

East River Bridge.

The New East River Bridge. Illustrated description of the progress of the work on this bridge at New York, with information concerning the plan and construction. 1800 w. Sci Am—Jan. 7, 1899. No. 25038.

Erection.

The Erection of the Attok Bridge, India. Illustrated account of the erection of three spans of 250 ft., and two of 300 ft. by means of lofty timber corbels. 800 w. Eng Rec—Jan. 28, 1899. No. 25582.

Highway Bridge.

Concrete and Expanded Metal Highway Bridge Construction in Allegheny County, Pa. Illustrates two methods of employing this material. Both bridges described are near Pittsburg. 600 w. Eng News—Jan. 26, 1899. No. 25542.

Melan Arch.

The New Bridge at Steyr. (Die Neue Schwimmschulbrücke in Steyr.) Describing a recently constructed bridge of 138 feet span, on the Melan principle of iron beams imbedded in concrete. The arch is hinged at the crown and springings. 3500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Dec. 23, 1898. No. 25474 B.

Plate-Girder.

Long Span Plate-Girder Bridge. Illustrated description of a railway span 105 ft. long and 9½ ft. deep, at Bridgeport, O. Explains both design and erection. 1000 w. Eng Rec—Jan. 14, 1899. No. 25236.

Pony-Truss.

Standard Plans for 120-ft. Pony-Truss Bridges, Northern Pacific Ry. Illustrates and describes the novel features of the pony trusses used. 900 w. Eng News—Jan. 5, 1899. No. 25029.

Rhine.

The New Bridge Over the Rhine between Bonn and Beuel. (Die Neue Rheinbrücke zwischen Bonn und Beuel.) An excellent illustrated description of this latest bridge over the Rhine. The central braced arch has a span of 614 feet. Three articles, 5000 w. Deutsche Bauzeitung—Dec. 24, 28, 31, 1898. No. 25452 each B.

Riveted Spans.

A Strong Though Damaged Bridge. Illustrated description of a 115 ft. heavy riveted lattice bridge, which permitted the passage of a heavy freight train after it had been severely injured. 600 w. Eng Rec—Jan. 21, 1899. No. 25350.

Short Span.

Construction of Short Span Railway Bridges. Henry Goldmark. Review of the fundamental principles governing the construction of culverts, arches, and truss bridges less than 175 ft. long. 3300 w. Eng Rec—Dec. 31, 1898. No. 24986.

Suspension.

A New Suspension Bridge at Niagara. Illustrates work and describes a new bridge in process of erection from near Lewiston, N. Y., to a point on the Canadian side, just above the village of Queenston, Ont. 1100 w. Ry Age—Dec. 30, 1898. No. 25002.

Highway Bridge Over the Argen at Langenargen. (Strassenbrücke über die Argen bei Langenargen.) Detailed description with numerous illustrations of a suspension road bridge of 220 feet span over the Argen in Bavaria. 1000

w. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 25470 D.

The Old and New Suspension Bridges Over the Niagara River at Lewiston, N. Y. Interesting accounts of these bridges, with illustrations. 2000 w. Eng News—Jan. 12, 1899. No. 25185.

Vauxhall.

New Vauxhall Bridge. A short description of the structure now being demolished, and an illustrated description of the new concrete arch bridge. 1200 w. Builder—Jan. 7, 1899. No. 25314 A.

Viaduct.

The Viaduct Over the Rhine at Eglisau. (Der Rhein-Viadukt bei Eglisau.) A fully illustrated description of this new viaduct, including the construction of the tall piers and masonry arches of the approaches, and the false works and details of the central truss; also graphical records of the deflections under test. Two articles. 3000 w. Schweizerische Bauzeitung—Dec. 17, 24, 1898. No. 25492 each B.

CANALS, RIVERS AND HARBORS.

Blasting.

Rock-Blasting Under Water. The methods employed in such work are described, and operations in the East River, N. Y., on the Danube, Rhine, &c., mentioned. 1400 w. Sci Am Sup—Jan. 7, 1899. No. 25040.

Canal Restoration.

Thames and Severn Canal. Brief account of the work of restoration recently completed. 800 w. Engr, Lond—Dec. 23, 1898. No. 25064 A.

Dam Failure.

The Destruction of a Dam at Tampa. Illustrated description of a dam failure caused by a dynamite explosion. 500 w. Eng Rec—Dec. 31, 1898. No. 24985.

Dismal Swamp.

Dismal Swamp Canal. An account of the reopening of this canal which connects the Chesapeake Bay with Albermarle Sound, and its importance as an inland waterway. 1800 w. Bos Jour of Com—Jan. 28, 1899. No. 25591.

Dortmund Canal.

The Harbor of the King Ludwig Works at Bruch. (Die Hafenanlage der Gewerkschaft König Ludwig zu Bruch.) A description of the harbor plant on the Dortmund-Ems Canal for the handling of coal and coke in connection with the Westphalian mining district. 2500 w. Glückauf—Jan. 1, 1899. No. 25495 B.

Dredgers.

The Conversion of the "Wenlock" from a Bucket to a Sand-Pump Dredger. A copy of the specification with illustration. 1800 w. Ind Engng—Dec. 3, 1898. No. 25141 D.

Flood Discharge.

Capacities for Culverts and Flood-Discharge. Abstract of a paper by George Chamier, presented at a recent meeting of the Inst. of Civ. Engs., London. Gives a formula proposed for average cases, with the results of tests. 1200 w. Eng News—Jan. 26, 1899. No. 25550.

Flood Discharges. George Chamier. An elaborate review of the run-off from different areas and a new formula for estimating it. 4500 w. Eng Rec—Jan. 21, 1899. No. 25353.

Hamburg.

The Recent Development of the Harbor of Hamburg. (Die Neuere Ausgestaltung der Hamburger Hafenanlagen.) A review of the growth of the commerce of the port of Hamburg from 1882 to 1895, showing the development due to improved facilities. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25490 D.

Levees.

Levees, with Special Reference to the Red River System. Frank M. Kerr. The geographical position of Red River and some of its general features are given, with an account of the work in progress and its aim. 7000 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25576 C.

Mississippi.

The Mississippi Floods, Their Cause and Prevention. The full text of the report of the Committee on Commerce, of the United States Senate, prepared with unusual care after consulting many experienced engineers. 6500 w. Eng Rec—Jan. 28, 1899. No. 25587.

The Mississippi River Floods and Methods for Their Control. From the report of the Committee on Commerce of the U. S. Senate. An examination of the causes, and necessary protection for property. 2400 w. Eng News—Jan. 26, 1899. No. 25543.

Nicaragua Canal.

Preliminary Report of the Nicaragua Canal Commission. Gives full text of this report, with brief comment. 1100 w. Eng News—Jan. 5, 1899. No. 25030.

The Nicaragua Canal in Congress. Editorial discussion of the amended bill as passed by the U. S. Senate. 2400 w. Eng News—Jan. 26, 1899. No. 25546.

Panama Canal.

General Abbot on the Panama Canal. Full text of the report presented to the U. S. Congress. 5500 w. Eng Rec—Jan. 14, 1899. No. 25235.

The American Isthmus and the Interoceanic Canal. W. Henry Hunter. A finely illustrated and complete description of the Panama canal, the plans of its engineers, present status of the work and future prospects. 5500 w. Engineering Magazine—Feb., 1899. No. 25434 B.

Regulating Streams.

The Regulation of Torrents and Mountain Streams. (La Sistemazione dei Torrenti e dei Bacini Montani.) A summary of Italian legislation on this point, now becoming very important in Italy. 1500 w. Giorn dei Lav Pubb e delle Str Ferr—Jan. 11, 1899. No. 25420 B.

Water Measurements.

Low Water Measurements in the State of California During the Summer of 1898. J. B. Lippincott. Tabulated summary of work and explanation of its value. 700 w. Eng News—Jan. 12, 1899. No. 25186.

Waterways.

Harbor and Waterway Engineering for 1898. A summary of the events of the past year in the United Kingdom showing great activity in this field. 4400 w. Engr, Lond—Jan. 6, 1899. No. 25273 A.

The Waterways of Russia. C. H. Moberly. An illustrated description of the waterways, excepting the Volga which has been previously described. 2800 w. Engng—Jan. 13, 1899. Serial. 1st part. No. 25381 A.

IRRIGATION.

Chinese Works.

Irrigation in the Celestial Empire. Illustrated account of Chinese works 2,000 years old which are constructed and maintained in an unusual, though successful, manner. 1400 w. Eng Rec—Jan. 28, 1899. No. 25583.

Irrigation Studies.

Stream Gagings and Other Studies Relating to Irrigation in Wyoming. Elwood Mead. Extracted from a forthcoming annual report. A statement of the conditions of streams and the influence of subterranean waters. 3500 w. Eng News—Dec. 29, 1898. No. 24949.

MISCELLANY.

Addresses.

Addresses Delivered at the Meeting to Commemorate the Semi-Centennial of the Boston Society of Civil Engineers, November 11, 1898. Gives the opening address by Howard A. Carson, president of the society; and the historical address by Desmond Fitzgerald, past-president. 7500 w. Jour Assn of Engng Soc'y—Dec., 1898. No. 25574 C.

Buckling.

Eccentric and Axial Resistance to Buckling. (Exzentrische und Zentrische Knickfestigkeit.) A. Ostenfeld. An analytical investigation, taking into account the formulæ of Euler, Johnson, and Rankine, and comparing these with the experiments of Tetmaier. 7500 w. Zeitschr d Ver Deutscher Ing—Dec. 31, 1898. No. 25467 D.

Graphical Investigation of the Buckling of Straight Columns. (Graphische Untersuchung der Knickfestigkeit Gerader Stäbe.) Luigi Vianello. With numerous diagrams showing the method of computing graphically the bending moments under various conditions. 7500 w. Zeitschr d Ver Deutscher Ing—Dec. 24, 1898. No. 25464 D.

Cement.

Tests of Frozen Cement Mortar. Report of numerous experiments by Arthur G. Fogg, showing freezing is not injurious under certain conditions. 2000 w. Eng Rec—Dec. 31, 1898. No. 24984.

The Fine Grinding of Portland Cement. David B. Butler. Describes a large number of experiments to determine the effect of fine grinding. 1500 w. Eng Rec—Jan. 28, 1899. Serial. 1st part. No. 25585.

Drafting.

Drafting Rules for Structural Iron Work. Illustrated reproduction of the instructions of the Pittsburg Bridge Co. to its draftsmen. 4800 w. Eng Rec—Jan. 14, 1899. Serial. 1st part. No. 25237.

Earth Resistance.

The Testing of Earth Resistance. (Beitrag über die Bodenuntersuchung.) Describing a method of determining the density of earth by pressure of weights upon a sharp wedge; data being thus obtainable for estimates of cost of excavation. 1000 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25491 D.

Examinations.

Grading Engineers by Examinations. Editorial review of the results of examinations conducted by the Institution of Civil Engs. and by civil service boards in the United States. 1800 w. Eng Rec—Dec. 31, 1898. No. 24981.

Highways.

A Russian Military Highway. Marsden Manson. An account of the road over the Caucasus. 800 w. Eng Rec—Jan. 28, 1899. No. 25586.

Metal Protection.

The Protection of Metal Work. A. H. Sabin. A lecture delivered at the University of Wisconsin. Gives rules for the best results and for good, but less thorough work. 1600 w. Eng Rec—Jan. 7, 1899. No. 25101.

Piers.

Difficult Pier Construction, Manhasset Viaduct, Long Island R. R. William A. Cattell. Illustrates and describes an unusual piece of work which caused much anxiety and expense. 900 w. Eng News—Jan. 12, 1899. No. 25184.

Public Works.

The Civil Engineer and National Public Works George Y. Wisner. A discussion of the gradual passage of public works from civil to military control, giving the history of the change and considering its wisdom. 4500 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25578 C.

Reenforced Concrete.

The Influence of Metallic Reënforcement upon Mortars and Cements. (Influence des Armatures Métalliques sur les Propriétés des Mortiers et Bétons.) M. Considère. An account of some experiments showing unexpected strength in samples of reënforced concrete. 2700 w. Comptes Rendus—Dec. 12, 1898, and Jan. 2, 1899. No. 25418 each D.

Review.

Civil Engineering. Editorial annual review of work, events, and undertakings in this field. 7500 w. Engr, Lond—Jan. 6, 1899. No. 25274 A.

Sanitary Engineering.

The Civil Engineer as a Guardian of the Public Health. J. B. Johnson. The paper aims to show that it is the duty of civil engineers to provide clean streets, pure water, and the quick removal of refuse and waste, and to lead in forming public sentiment to secure these results. 4500 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25577 C.

Shield Driving.

A Wooden Lining for Shield-Driven Tunnels. Illustrates and describes methods used in the construction of the sewerage system of Melbourne, Australia. 1000 w. Eng News—Dec. 29, 1898. No. 24944.

Structural Materials.

Durability of Structural Materials. A. H. Sabin. On what the durability depends, with special discussion of iron and steel. 1500 w. Wisconsin Engr—Jan., 1899. No. 25206 D.

Vienna.

The Oldest Plan of Vienna. (Der Aelteste Plan von Wien.) Siegmund Wellisch. A description of the so-called Albertin map of Vienna made in 1438, valuable both for historical reasons, and also as the earliest known example of municipal surveying. Comparisons with succeeding surveys are given. 3500 w. Zeitschr d Oesterr Ing Arch Ver—Dec. 30, 1898. No. 25476 B.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Coal.

American Coal in Marseilles. A report giving information concerning a market for this product, most favorable to its introduction. 500 w. U. S. Cons Repts, No. 336—Jan. 28, 1899. No. 25580 D.

American Commerce.

The Promotion of American Commerce. Full text of the considerations presented by Jacob H. Gallinger, of New Hampshire, in respect to senate bill No. 5024. 3300 w. Naut Gaz—Jan. 26, 1899. Serial. 1st part. No. 25527.

Argentina.

English and American Trade in Argentina. F. C. Chappell. Presents facts concerning English and American trade with suggestions helpful to American exporters. 1200 w. Am Mach—Jan. 5, 1899. No. 25081.

Bourse.

America's Great Bourse. W. J. Casey. An account of the Philadelphia Bourse and its benefit in the business development of the nation, noting its principal features. 2000 w. Mfrs Rec—Jan. 20, 1899. No. 25331.

China.

American Trade and Policy in China. Information and suggestions from a personal letter to the editor, with comments. 1500 w. R R Gaz—Jan. 6, 1899. No. 25076.

Trade with China. Charles Denby, Jr., in the *N. Y. Journal of Commerce*. A reply to an article of Worthington C. Ford, in the Sept. number of the *Atlantic Monthly*, presenting statements showing the opportunities for American enterprise in this field. 1800 w. Bos Jour of Com—Jan. 7, 1899. No. 25144.

United States' Trade with China in Iron and Steel. Indications of soon becoming a large market for these products. 1500 w. Am Mfr & Ir Wld—Jan. 13, 1899. No. 25244.

Commercial Traveling.

Commercial Traveling in South America. William E. Torrens. Comments and suggestions from an observant traveler. 1700 w. Nat Assn of Mfrs, No. 29—Jan. 16, 1899. No. 25327.

Competition.

America and Germany as Export Competitors and Customers. Louis J. Magee. This paper, the first of a series, deals with the importance of industrial exports and the desirability of national recognition of this importance. 3400 w. Engineering Magazine—Feb., 1899. No. 25437 B.

American Competition with British Industries. Extracts from the *Glasgow Herald*, with comments. 1800 w. U. S. Cons Repts, No. 324—Jan. 14, 1899. No. 25243.

Some Notes on American Manufactures. J. Grant Birch. Part first considers some of the characteristics of American manufactures as compared with English, and mentions the labor conditions that impressed him during a recent visit. 1600 w. Engng—Dec. 16, 1898. Serial. 1st part. No. 25207 A.

Customs.

Customs Invoices in Canada. Copy of a circular issued by the Canadian customs, regarding invoices for customs entry under the general tariff. 2200 w. U. S. Cons Repts, No. 326—Jan. 17, 1899. No. 25265 D.

Duties.

Rate of Duty Imposed on Iron and Steel by Leading Foreign Countries. Compiled by James M. Swank. Part first reports Great Britain, France, Germany, Sweden, and Russia. 1700 w. Am Mfr & Ir Wld—Jan. 20, 1899. No. 25399.

Exporters.

Bolts and Nuts in England: Mistakes of United States Exporters. Comments from British papers on the disparity between English and American prices, with remarks on the mistake of underselling to the extent of demoralizing prices. 2000 w. U. S. Cons Repts, No. 319—Jan. 9, 1899. No. 25130 D.

Failures.

Failure Statistics—Their Meaning and Utility. The year 1898 shows the smallest in number and liabilities in the United States since 1892. Reviews the effects of conditions prevailing and gives tabulated statements for comparison. 7500 w. Bradstreet's—Jan. 21, 1899. No. 25366.

French Iron Trades.

"Temporary Admissions" in the French Iron and Steel Trade. J. W. Root. States the conditions in France which handicap her iron and steel industries, explaining the admission of foreign imports under name designated, and the working up of this semi-raw material. 2200 w. Ind & Ir—Dec. 30, 1898. No. 25162 A.

Germany.

Foreign Commerce and Industrial Progress in Germany. A review of the year 1897-98, showing the general prosperity of German industries, and giving information of interest relating to the foreign trade of the country. 3800 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25027 D.

Iron Ore Trade.

Thirteenth Annual Review of the Lake Superior Iron Ore Trade. Horace J. Stevens. Report of large output and small profits, giving much information. Also discusses the prospects for the coming year. 2200 w. Am Mfr & Ir Wld—Jan. 6, 1899. No. 25178.

Iron Trade.

Pittsburg Iron Trade in 1898. Report concerning pig iron, plates, sheets, and other finished materials, with general remarks. 2200 w. Ir Trd Rev—Jan. 5, 1899. No. 25085.

The Chicago Iron Trade in 1898. George W. Cope. General review of the trade, with a partial record of prevailing prices. 4500 w. Ir Age—Jan. 5, 1899. No. 25015.

The Competition for Iron and Steel Markets in 1898. Statements based on figures from official reports of various countries showing progress or regress of exports, and comparisons showing that the progress made by the United States has surpassed all others. 2800 w. Ir Age—Dec. 29 1898. No. 24962.

The French Iron and Steel Trade in 1897. Statistics from recent returns of the foreign commerce of France. 2000 w. Ind & Ir—Dec. 23, 1898. No. 25054 A.

The Pittsburg Iron Trade in 1898. Robert A. Walker. An interesting review of the year, dealing with production, foreign trade, new construction, combinations and trusts, and the outlook. 7400 w. Ir Age—Dec. 29, 1898. No. 24961.

Japan.

Trade Conditions in Japan: Opening for American Goods. Extracts from the annual report of Consul Lyon. The peculiarities and prejudices that affect trade, and brief consideration of certain exports and imports. 2200 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25023 D.

Leather.

Leather Manufactures in Germany. Reports the striking progress in the tanning and leather industries, and gives suggestions for American shoe manufacturers, for increasing trade. 1800 w. U. S. Cons Repts, No. 320—Jan. 10, 1899. No. 25146 D.

Liverpool.

Trade of Liverpool with the United States. From the annual report of Consul Boyle, of Liverpool. An account of trade in general and of particular lines; of Canadian competition, &c. 2400 w. U. S. Cons Repts, No. 315—Jan. 4, 1899. No. 25011 D.

Machinist's Hardware.

Screws, Nuts and Bolts in Foreign Countries. Consular reports from various parts of Europe giving information relative to the manufacture and trade in these products. Calls attention to the fact that Withworth's standard thread is so generally used as to make it useless to attempt to introduce any other system. 9000 w. U. S. Cons Repts—Vol. XV, 1898. No. 25021 D.

Mexico.

Commerce and Industries of Mexico. Extract from report of Consul-General Barlow. Information relating to climate, agricultural and other products, imports, exports, &c., &c. 3000 w. U. S. Cons Repts, No. 313—Dec. 31, 1898. No. 24964 D.

Oil Trade.

The Growth of Our Oil Trade. William Gilbert Irwin. A detailed account of the opening and production of the oil fields of the United States. 2500 w. Sci Am—Jan. 14, 1899. No. 25190.

Para.

Commerce of Para. Information from the annual report of Consul Kenneday, on the expansion of trade, in classes of goods furnished by the United States, and the opportunities. 4800 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25025 D.

Prices.

Staple Prices Highest for Five Years. Statements regarding the Dec. prices, showing them to be at a higher level than at any time since 1893. 600 w. Bradstreet's—Jan. 14, 1899. No. 25228.

Rebates.

Rebates on Imported Goods in Cape Colony. A copy of the schedule reducing the rebate on imported goods passing through the colony to the inland states. 3000 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25024 D.

Review.

The Iron and Steel Trades in the United Kingdom in 1898. General review of the conditions, output, rates, charges and imports. 10,000 w. Ir & Coal Trds Rev—Dec. 30, 1898. No. 25161 A.

Russia.

Suggestions Concerning Trade with Russia. Information of value to exporters, showing the opportunities for United States trade and the best methods of extending the market. 2500 w. U. S. Cons Repts, No. 325—Jan. 16, 1899. No. 25196 D.

Shipping.

Ocean Shipping and the Export Trade. Willard S. Mattox. On the importance of providing for the movement of American goods to foreign ports. 1800 w. Ir Age—Jan. 12, 1899. No. 25211.

South Africa.

British vs. American Goods in South Africa. Extract of an article from the *British and South African Gazette*, in reference to preference in South Africa for American goods, with the editor's comments. 3000 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25022 D.

South Wales.

The Recovery in South Wales. On the re-

markable recuperative power of the coal and iron trades. 1200 w. Engr, Lond—Jan. 13, 1899. No. 25391 A.

Statistics.

The Business Year. Statistical summary showing the commercial, industrial and financial results of the year 1898. 6800 w. Bradstreet's —Dec. 31, 1898. No. 24953.

Steel Trade.

The Future of the South Staffordshire Iron and Steel Trades. H. Le Neve Foster. Extract from presidential address, considering the manner in which further progress could be made in the Midlands, and noting many points of interest. 2000 w. Col Guard—Jan. 13,1899. No. 25389 A.

Tariff Changes.

Proposed Tariff Changes in Belgium. Gives a copy of the project of law relative to the collection of duty on goods taxable ad valorem. 900 w. U. S. Cons Repts, No. 335—Jan. 27, 1899. No. 25579 D.

Trusts.

Can Consolidation Be Regulated by Law? Editorial advising the passing of a law requiring reports to be published of the business of all incorporated companies. 1400 w. Ir Age—Jan. 12, 1899. No. 25212.

Turkey.

Commercial Conditions in Turkey. Information of interest to exporters of American goods. 2500 w. U. S. Cons Repts, No. 318—Jan. 7, 1899. No. 25131 D.

Venezuela.

Cotton Goods Trade of Venezuela. William Whittam, Jr. Investigations and observations of a manufacturer and mill engineer, with comments on the commercial conditions of the country. 9500 w. Nat Assn of Mfrs, No. 28 —Jan. 5, 1899. No. 25326.

Warehouse.

Need of an American Warehouse in China. Urging the need of an exposition in China to extend the American trade, and discussing the peculiarities of the people which must be understood in carrying on trade. 1000 w. U. S. Cons Repts, No. 316—Jan. 5, 1899. No. 25012 D.

CURRENCY AND FINANCE.

Loans.

Foreign Loans in China. Prescribing the necessary course to be pursued in contracting foreign loans for opening mines and constructing railroads in China. 800 w. U. S. Cons Repts, No. 332—Jan. 24, 1899. No. 25395 D.

Monetary Commission.

The Final Report of the Monetary Commission. Frederick A. Cleveland. An examination of the "facts and arguments" presented in this report, affirming that the arguments do not justify the conclusions, and the facts presented are inadequate. 8000 w. An Am Acad—Jan., 1899. No. 25001 F.

Money.

The Functions and Qualities of Money. Charles A. Conant. The subject is treated from the standpoint of the evolution of money, tracing the growth from the barter of primitive times to the mechanism of the modern exchange, with a glance at the possibilities of the future. 6000 w. Bankers' Mag, N. Y.—Jan., 1899. Serial. 1st part. No. 25218 D.

GOVERNMENTAL CONTROL.

Patent Rights.

The Nature and History of Patent Rights. E. L. Thurston. A consideration of those rights respecting an invention which are created by the grant of a patent. Also discusses changes made in the patent laws of the United States, with general discussion by members. 5800 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25575 C.

LABOR.

Address.

Labor from a Technical and Economic View. (Technische und Wirtschaftliche Arbeit.) An address by Prof. Dr. Ehrenberg discussing the relation of applied technology to the practical industrial and commercial problems of the day. 7500 w. Zeitschr d Ver Deutscher Ing—Dec. 17, 1898. No. 25462 D.

Disputes.

The Effect of Labor Disputes on Foreign Trade. Mr. Ritchie's talk to a committee from the Trade Union Congress, on the desirability of an industrial peace, and the loss to labor and capital because of strikes in England. 1400 w. Col Guard—Dec. 23, 1898. No. 25059 A.

Primitive Industry.

Sex in Primitive Industry. W. J. Thomas. A study of the division of labor. 5000 w. Am Jour of Soc—Jan., 1899. No. 25247 D.

Unions.

Trade Unions and Public Duty. Jane Addams. A comparison of trades union and national measures, with defense of the methods employed by unions, and condemnation of the general public in its attitude toward industry. 6500 w. Am Jour of Soc—Jan., 1899. No. 25246 D.

Wages.

Some Valuable Wage Statistics. Considers statistics given in the Sept. number of the Bulletin of the U. S. Dept. of Labor. 2000 w. Gunton's Mag—Jan., 1899. No. 25070 C.

Working Hours.

Working Hours in French Industrial Establishments. (La Durée du Travail dans les Etablissements Industriels.) Résumé of the report of a commission appointed to supervise the application of the French factory law of 1897, with statistical data. 1200 w. Moniteur Industriel—Jan. 7, 1899. No. 25425 E.

MISCELLANY.

Beet Cultivation.

Beet Cultivation in Italy. Reports tabulated results of experiments carried out in Italy. 600 w. U. S. Cons Repts, No. 316—Jan. 5, 1899. No. 25013 D.

Brickmaking.

Brickmaking in England—The Accrington Shale District. John A. Turner. Historical and descriptive account with illustrations of machinery employed and of the works. 4000 w. Brick—Jan., 1899. No. 25250.

Cuba.

Cuban Reconstruction. Richard J. Hinton. Discusses the resources and industries of this island, the wrongs that have caused such disaster, the difficulties in the situation, &c. 4500 w. N Am Rev—Jan., 1899. No. 24979 D.

Personal Observations in Cuba During the War. J. W. Hopley. An account of the clay industry in the island with illustrations of Cuban scenes. 2800 w. Brick—Jan., 1899. No. 25248.

Hawaiian Islands.

Agriculture in the Hawaiian Islands. Dr. Harvey W. Wiley. Information concerning the character and formation of the soils, their fertility, the rainfall, crops and the conditions attending the practice of agriculture. 7500 w. Jour Fr Inst—Jan., 1899. No. 25127 D.

Paris Exposition.

The Approaches and Transportation Facilities of the Paris Exposition of 1900. E. L. Corthell. Information collected during a recent visit, including illustrated descriptions of the engineering works connected with the subject. 7500 w. Pro of Am Soc of Civil Engs—Jan., 1899. No. 25573 F.

The United States at the Paris Exposition in 1900. Ferdinand W. Peck. The importance to American trade of a fine exhibit and the value of this opportunity. 3500 w. N Am Rev—Jan., 1899. No. 24977 D.

The Paris Exposition of 1900. Francis S. Drake. Plan and illustrations with description, and general conditions and special features. 5000 w. St Ry Jour—Jan., 1899. No. 25037 D.

Prizes.

The Public Session of the French Academy of Sciences. (Séance Publique de l'Académie des Sciences.) The annual volume published by the Academy, containing the minutes of the public meeting, the award of prizes for the year past and notices of the prizes to be awarded next year. 60,000 w. Comptes Rendus—Dec. 19, 1898. No. 25419 D.

Report.

Annual Report of the President of the National Association of Manufacturers. Theodore C. Search. An interesting account of the year's work, discussing legislative measures, shipping, Nicaragua canal, Paris exposition, trade marks, international freght and transportation, &c. 12,500 w. Nat Assn of Mfrs, Form 316—Jan., 1899. No. 25373.

Review.

Commerce, Manufactures and Products. O. P. Austin. A review of the record made by the United States in the year 1898. 3000 w. Bankers' Mag, N. Y.—Jan., 1899. No. 25217 D.

Rubber.

Improvements in Vulcanization. (Modifications Apportées à la Vulcanisation au Soufre.) Report by Ach. Livache, upon a new process, due to MM. Bapst and Hamet. They use a bath of molten sulphur, kept hot by a steam jacket, so that the temperature is easily regulated and no inflammable vapors produced near a flame, as is the case when the bath is heated by a fire. Illustrated. 2000 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25403 G.

Methods of Preparing Rubber. R. H. Biffen. Considers some of the better-known varieties of rubber and the methods of preparation, and the need of research in this field. Reports the writer's recent success in preparing pure rubber by a physical process. 3000 w. Jour Soc of Arts—Dec. 23, 1898. No. 25095 A.

Technical Education.

Technical Education at the University of Wisconsin. Storm Bull. Reviews the history of technical education at this university. Ill. 4800 w. Wisconsin Engr—Jan., 1899. No. 25200 D.

The Education of Electrical Apprentices and Journeymen. Arthur A. Hamerschlag. Read at meeting of the Am. Inst. of Elec. Engs. Urging that the educating of apprentices and journeymen bears a vital relation to the future success or failure of the industry. 2800 w. Elec, N. Y.—Jan. 11, 1899. No. 25210.

The International Correspondence Schools, Scranton, Pa., with Special Reference to the Courses in Mining. H. H. Stork. An account of this undertaking and its marked success, with an outline of courses and methods. 4500 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24969 D.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Cables.

A Great Telegraph Scheme. Editorial discussion of the scheme to establish a complete system of cables around the globe, to be owned by the British government, maintaining that it would be best for the work to be carried out by private enterprise. 1500 w. Engr, Lond—Dec. 23, 1898. No. 25067 A.

Cables For Alternating Currents. (Wechselstrom-Kabelnetz.) H. Andriessen. A discussion of methods of increasing the capacity of cables, with especial reference to concentric cables. 1500 w. Elektrotech Zeitschr—Dec. 15, 1898. No. 25497 B.

Submarine Cable Laying. (La Pose des Cables Sous-Marins.) L. Moreval. A well illustrated general description of methods employed. 5000 w. Le Génie Civil—Dec. 17 and 24, 1898. No. 25410 each D.

Duplex Telephony.

The Duplexing of Telephone Conductors.

(Doppelbenutzung von Fernsprech-Verbindungsleitungen.) A paper by Inspector Schwensky, discussing the various methods which have been used for sending telephone communications simultaneously over one wire, with especial reference to the method used by the German government. 7500 w. Elektrotech Zeitschr—Dec. 22, 1898. No. 25444 B.

"Independent" Telephony.

Some of the Latest Practice in "Independent" Telephony, at Battle Creek, Mich. Describes one of the latest, most convenient and economical systems in the independent field. Ill. 1000 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25175.

Recorder Signal.

Siphon Recorder Signals. J. Rymer-Jones. Gives a series of illustrated experiments conveying information of value concerning the working of the Recorder under widely different conditions, on cables differing in length. 900 w. Elec Rev, Lond—Jan. 13, 1899. Serial. 1st part. No. 25511 A.

Space Telegraphy.

Coast-Telegraphs and Space-Telegraphy. Rollo Appleyard. The present limits of space telegraphy, the methods of coast telegraphs tried, and the success attained, with the methods now in favor. 4200 w. Nature—Jan. 12, 1899. No. 25507 A.

Hertz-Wave Telegraphy. (La Telegraphie Hertzienne sans Fil.) E. Ducretet. An illustrated historical and descriptive paper clearly presenting the status of present knowledge of the subject. 4500 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25405 G.

Telegraphy by Magnetic Induction. S. Evershed. Read before the Inst. of Elec. Engs., England. The low-frequency electromagnetic system is presented; the method of forming the primary and secondary circuits, transmitting and receiving devices. 2700 w. Ind & Ir—Dec. 30, 1898. No. 25163 A.

Telegraphing Without Line Wires. William Bissing. Reviews the electrical development bearing on this form of signaling. Part first considers conduction, induction, and electromagnetic methods. 3000 w. Elec Wld—Jan. 14, 1899. Serial. 1st part. No. 25260.

The Zickler Electric Luminous Wireless Telegraph System. Describes a design differing essentially from proposed systems. It consists in utilizing ultra violet rays. Ill. 900 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25532.

Telegraphy.

Notes on Telegraphy and Telephony. W. H. Freedman. The present paper is devoted to telegraphy, giving its history, systems of codes, generators used, &c. 5800 w. Sch of Mines Qr—Nov., 1898. No. 25199 D.

Telephoning.

The Use of Telegraph Wires For Telephoning. (Auschaltung von Fernsprechsystemen an Morseleitungen.) O. Canter. Describes a method for the application of telephones to wires which are at the same time used for Morse telegraphing, in such a manner that neither interferes with the other even when used simultaneously. 1000 w. Elektrotech Zeitschr—Dec. 15, 1898. No. 25498 B.

DISTRIBUTION.

Mains.

Mains for Electricity Supply. F. J. Warden-Stevens. Considers the cables and the methods of laying them. 3300 w. Arch, Lond—Jan. 6 1899. Serial. 1st part. No. 25311 A.

Secondary Circuits.

Design of Secondary Circuits in Alternating Plants. George L. Thayer. Gives details of what is becoming standard practice, discussing improvements in the direction of better regulation and increased efficiency of distribution. 3800 w. Elec Wld—Jan. 28, 1899. No. 25594.

Switchboards.

Listening and Ringing Equipment for Switchboards. H. P. Clausen. Considers the various systems and devices in use. Ill. 2000 w. W Elect'n—Dec. 31, 1898. No. 24999.

Switzerland.

Electric Power in Switzerland. W. Cotgrave Betts. Some facts are given showing the rapid progress already made in the application of electric power to industrial purposes, but concluding that considering the natural conditions, electricity has not gained favor as rapidly as expected. 900 w. Power—Jan., 1899. No. 25092.

Utilization of the Rhine Water-Power in Switzerland. (L'Utilisation des Forces Motrices du Rhin en Suisse.) Illustrated account of the proposed exploitation of this power by the Swiss government. 2000 w. Le Génie Civil—Jan. 7, 1899. No. 25417 D.

Transformer Equipment.

The New Transformer Equipment of the Carborundum Company at Niagara Falls. J. S. Peck. Briefly describes the process of manufacture of carborundum, and the new transformer and regulator recently installed which doubles the capacity of the plant. Ill. 2500 w. Elec Wld—Jan. 7, 1899. No. 25168.

The Transforming Central Station of the Buffalo General Electric Company. Illustrates and describes this station, belonging to the Niagara system, and made necessary for adaptation of Niagara power for the various services. 3800 w. Elec Wld—Jan. 28, 1899. No. 25593.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulator-Regulating Devices. Illustrates and describes the Heath and Field system. 900 w. Elec Eng, Lond—Jan. 13, 1899. No. 25515 A.

International Competitive Trials of Accumulators for Road Traction. Gives the programme of a competition that has been arranged for the trial of accumulators intended for automobile vehicles driven on ordinary roads. 2400 w. Elec Rev, Lond—Jan. 6, 1899. No. 25308 A.

Storage Batteries for Road Traction. Brief

discussion of the batteries used in France for electric traction on common roads. 1100 w. Elec Rev, Lond—Dec. 23, 1898. No. 25052 A.

Aqueous Solutions.

Electrolytic Decomposition of Aqueous Solutions. L. Glaser. From the *Zeitschrift für Electrochemie*. Part first considers the formation of water in the gas battery (H O cell), and the decomposition of water. 1200 w. Elec Rev, Lond—Jan. 6, 1899. No. 25309 A.

Copper.

The Electrolytic Copper Industry. Gives details of production, conduct of the refining operations, &c. 1400 w. Engng—Dec. 30, 1898. No. 25155 A.

Electric Furnace.

See Heating and Welding.

Electromotive Force.

Changes of Electromotive Force Within the Secondary Cell. Charles Frederick Burgess. Deals with the means which are available for studying single potential differences which exist in different parts of the cell, and gives some of the data which was obtained in the application of one of these methods. 3700 w. Wisconsin Engr—Jan., 1899. No. 25202 D.

Mill Scale.

The Removal of Mill Scale and Magnetic Oxide by Electricity. Sherard Cowper-Coles. Describes processes that have been tried for the removal of mill scale from forgings and plates. 700 w. Engng—Dec. 30, 1898. No. 25156 A.

Photographic Action.

The Chemical Action of the Electric Current on Gelatino-Bromide Dry Plates. (Die Chemischer Wirkung des Elektrischen Stromes auf Bromsilber – Gelatin – Trockenplatten.) Emil Jahr. With reproductions of plates upon which the current has acted. Tests were made with currents of various tensions. 1200 w. 1 plate. Elektrochemische Zeitschr—Jan., 1899. No. 25450 H.

Review.

Applied Electro-Chemistry: A Retrospect and a Prospect. E. Edser. Notes briefly applications successful and unsuccessful. 2200 w. Elec Eng, Lond—Jan. 6, 1899. No. 25324 A.

Electro-chemistry in the Year 1898. (Die Elektrochemie im Jahre 1898.) A general index of the important papers which have appeared in the technical journals of many countries upon electrochemistry and allied branches. 4000 w. Elektrochemische Zeitschr—Jan., 1899. No. 25451 H.

The Electro-Chemical and Electro-Metallurgical Industries in 1898. John B. C. Kershaw. Reports steady advance along the industries already in operation, but no new developments of importance. Deals with the more important industries seriatim. 2000 w. Elec Rev, Lond—Jan. 13, 1899. Serial. 1st part. No. 25513 A.

ELECTRO-PHYSICS.

Radiography.

A New Process of Printing by the Use of X-Rays. Typo-Radiography Faster Than Any Conceivable Method Now Used. Frederick Strange Kolle. An account of experiments in this field, with description of preparation of inks, and report of results obtained. 3500 w. Elec Eng, N. Y.—Jan. 19, 1899. No. 25339.

Izambard Process of Printing by X-Rays. Brief account of experimenting with Röntgen rays in the hope of adapting them to commercial use in the printing industry. 1000 w. Elec Eng, N. Y.—Jan. 12, 1899. No. 25222.

Roentgen Rays. W. C. Roentgen. Reports some experiments. 1600 w. Sci Am Sup—Dec. 31, 1898. No. 24942.

Tempered Steels.

The Magnetic Properties of Tempered Steels. A condensed translation of an article by Mme. Sklodowska Curie, in the *Bulletin de la Société d'Encouragement pour l'Industrie*, giving an account of her numerous systematic experiments. Ill. 2000 w. Elec Rev, Lond—Jan. 13, 1899. Serial. 1st part. No. 25512 A.

GENERATING STATIONS.

Armatures.

Practical Balancing of Armatures. George T. Hanchett. An illustrated explanation of the writer's ideas on this subject. 1300 w. Elec Eng, N. Y.—Dec. 29, 1898. No. 24936.

Beauport, Canada.

Electrical Plant at the Beauport Insane Asylum. Illustrates and describes a complete plant of small size which furnishes light and power. 1000 w. Can Elec News—Jan., 1899. No. 25256.

Boston, Mass.

The Power Plant of the American Soda Fountain Company, Boston, Mass. H. W. Weller. A combination of electrical and mechanical transmission designed with careful attention to first cost and economy. Ill. 3500 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25530.

Brushes.

The Contact Resistance of Carbon and Copper Brushes. (Der Kontaktwiderstand von Kohlen und Kupferbürsten.) E. Arnold. A very complete account of comparative tests made upon brushes of various materials, with diagrams showing the resistance, wear temperature, and other data; the results being discussed mathematically. 3000 w. Elektrotech Zeitschr—Jan. 5, 1899. No. 25447 B.

Carlisle, England.

Carlisle Electricity Supply Station. Illustrated detailed description of a station designed by A. B. W. Kennedy. It is a three-wire system, with an earthed middle wire and 460 volts between the outers. Also editorial. 3000 w. Elect'n, Lond—Dec. 23, 1898. No. 25049 A.

Compounding.

The Automatic Compounding of Alternating Dynamos. Maurice Leblanc. Extracts from a paper recently presented before La Société Internationale des Electriciens, describing an ingenious system of compounding. Ill. 1400 w. Elec Wld—Jan. 14, 1899. No. 25261.

Dynamos.

The Magnetic Elements of Dynamo Construction. J. Warren. A study of the laws of magnetism in their bearing on dynamo design. 1100 w. Elec, Lond—Dec. 23 and 30, 1898. Serial. 2 parts. No. 25046 each A.

Field Windings of Dynamos. Arthur L. Rice. The use of field winding is explained and the considerations which determine the size of wire, and other important determinations. 2000 w. Am Elect'n—Jan., 1899. No. 25564.

Dublin.

The Power Station of the Dublin United Tramways Co., Limited, Dublin, Ireland. Illustrated detailed description of a station designed to furnish power for an extensive system. 900 w. Power—Jan., 1899. No. 25091.

Grenada.

Steam-Driven Electric Station at Grenada, Spain. (Usine Electrique à Vapeur de Grenade, Espagne.) R. B Ritter. Illustrated description of an interesting plant, using Niclausse boilers, simple engines and single phase high-tension alternators. 4000 w. 1 plate. Le Génie Civil—Dec. 24, 1898. No. 25413 D.

Jamaica, W. I.

An American Light and Power Plant, Montego Bay, Jamaica, West Indies. Illustrates and describes a plant started recently and running satisfactorily. 900 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25172.

Lighting Works.

Electric Lighting Works. Neville Appelbee. Some of the more important points in designing the mechanical portions of steam-driven electricity works, and the plant used in them. 2600 w. Prac Engr—Jan. 6, 1899. No. 25304 A.

Lyons.

The Utilization of the Power of the Rhone at Lyons. (Ausnützung des Wasserkraft des Rhôneflusses bei Lyon.) Anton Klir. An illustrated description of the canal de Jonage which cuts across a loop of the Rhone and enables 12,000 h. p. to be utilized at Lyons. 4000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25488 D.

Niagara.

Lessons from the Niagara Power Plant. Reviews the statements of Dr. Coleman Sellers concerning the changes considered necessary by experience in operating the plant. 1200 w. Eng Rec—Jan. 14, 1899. No. 25240.

The Niagara Falls Power Plant. J. E. Woodbridge. The subject is treated from an engineering standpoint, giving reasons for adopting some of the features and details in the design, the additions just completed, and the conclusions which may be drawn. Fully illustrated. 9500 w. Elc Wld—Jan. 7, 1899. No. 25167.

The Power Plant of the Niagara Falls Hydraulic Power and Manufacturing Company. Illustrates and describes the plant, and the uses to which the power is applied. Also describes the Canadian Power Plant. 4500 w. Elec Wld—Jan. 14, 1899. No. 25259.

Paderno.

The Electric Station of Paderno on the Adda. (Das Elektricitätswerk in Paderno d'Adda.) E. Vannotti. An illustrated account of the hydraulic plant at Paderno, Italy; where 13,000 h. p. is developed and transmitted electrically over 19 miles. 3000 w. Elektrotech Zeitschr —Jan. 5, 1899. No. 25446 B.

Salisbury, England.

Salisbury Electric Light Station. Illustrates and describes this English station recently opened, with brief history of the buildings utilized. 2500 w. Elec Eng, Lond—Dec. 23, 1898. No. 25048 A.

Sparking.

The Limit of Sparking for Continuous Current Dynamos. (Die Funkengrenze bei Gleichstrommaschinen.) Gisbert Kapp. A mathematical derivation of a formula for the proportions which will prevent sparking in continuous current dynamos. 3000 w. Elektrotech Zeitschr —Jan. 5, 1899. No. 25448 B.

The Sparking of Continuous Current Dynamos. (Ueber die Funkenbildung an Gleichstrommaschinen.) J. Fischer-Hinnen. An elaborate mathematical analysis of the phenomena of sparking from a theoretical standpoint, deriving formulae adapted for practical use. Two articles. 10,000 w. Elektrotech Zeitschr—Dec. 22, 29, 1898. No. 25499 each B.

Storage Stations.

The Storage Battery Substations of the Metropolitan Street Railway, New York City. Describes the station at the foot of West 23d St., noting the peculiarities. 1900 w. Elec Wld—Jan. 21, 1899. No. 25332.

Switchboards.

The Electric Light and Power Switchboard. S. H. Sharpstein. Presents points of importance in relation to switchboard construction. 2000 w. Am Elect'n—Jan., 1899. No. 25569.

Transformers.

The Design of Transformers. Frederick W. Carter. On the best proportions to give to transformer cores, and the most advantageous distribution of the wasted energy, together with a direct method for the design of transformers, in order to obtain maximum all-day efficiency. Discussion. 9000 w. Trans of Am Inst of Elec Engs—Nov., 1898. No. 25522 D.

Washington, D. C.

Power House of the Capital Traction Company. Illustrated description of a 2000 k w station for a conduit electric road. 1500 w. Eng Rec—Dec. 31, 1898. No. 24989.

The New Power Station of the Capital Traction Co, Washington, D. C. Illustrated detailed description of the station and its equipment. 3700 w. St Ry Jour—Jan., 1899. No. 25032 D.

The Power Station of the Capital Traction Co., Washington, D. C. Describes and illustrates this new electric station, giving two-page plate. 2500 w. Eng News—Jan. 26, 1899. No. 25544.

HEATING AND WELDING.

Electric Furnace.

The Electric Furnace. F. Jarvis Patten. Illustrates and describes different furnace systems, giving briefly the history of researches in this field. 3300 w. Am Elect'n—Jan.,1899. No. 25562.

The Principal Electric Furnaces of 1897. (I Principali Forni Elettrici del 1897.) L. Belloc. A collection of illustrated descriptions of all the types of electric furnaces brought out in that year. 6000 w. L'Elettricita--Dec., 1898. No. 25421 E.

Transformers.

A Design for a Small Welding Transformer. George T. Hanchett. An illustrated description of a simple device of this class, which can be made from cheap materials with simple tools. 2000 w. Am Mach—Jan. 26, 1899. No. 25539.

LIGHTING.

Arcs.

Arcs and Non-Arcing Metals. George T. Hanchett. States phenomena observed and presents conclusions drawn, methods of avoiding arcs, &c. 1700 w. Am Elect'n—Jan., 1899. No. 25566.

Isolated Plant.

I. Some Practical Hints on the Production and Use of Electricity for Lighting Country Houses. Bernard M. Drake. II. Practical Applications of Electric Power. H. R. J. Burstall. The first paper considers the different methods, treatment of rooms, &c. The second paper discusses the general principles and the question of cost, describing typical forms of apparatus. Both papers are illustrated, and are discussed together. 10,500 w. Jour Roy Inst of Brit Archts—Dec. 24, 1898. No. 25506 B.

Lamp Factory.

A Modern Arc-Lamp Factory. Illustrated description of the plant of the Standard Thermometer and Electric Co. at Peabody, Mass. 1500 w. Elec Rev, N. Y.—Jan. 4, 1899. No. 25018.

Light and Power Co.

The History and Growth of the People's Light and Power Company of New Jersey. Max Loewenthal. Full illustrated account of the organization and expansion of this company. 6300 w. Elec Eng, N. Y.—Jan. 5. 1899. No. 25171.

Lighting Works.

See Generating Stations.

Small Plants.

Why Some Small Electric Light Plants Do Not Pay. J. R. Cravath. Discusses the engineering and business management, noting the mistakes often made. 2300 w. Elec Eng, N. Y.—Jan. 12, 1899. No. 25221.

MEASUREMENT.

Bridge.

Modified Bridge Method of Measuring Resistances Containing Earth Currents. R. R. Black. Describes a method of measuring the resistance of a cable by reversals when earth currents are strong and variable. 450 w. Elect'n, Lond—Jan. 13, 1899. No. 25516 A.

Counter.

Scribner's Connection-Counting Mechanism for Telephone Lines. Illustrated description. 800 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25531.

Hysteresis Meter.

The Blondel-Carpentier Hysteresis Meter. (L'Hysteresimetre Blondel-Carpentier.) A. Blondel. Illustrated description of an ingenious instrument for measuring hysteresis in a sample of metal. 1200 w. L'Electricien—Jan. 7, 1896. No. 25423 B.

Leakage.

A Direct Reading System for Measuring Current Leakage. Dr. M. Kallmann. Abstract of a paper read before the Verband Deutscher Elektrotechniker. Describes the system and enumerates its most important applications. 2200 w. Elect'n, Lond—Dec. 23, 1898. No. 25050 A.

Meters.

General Meter Practice. Lyman C. Reed. Deals with the practical arrangement of a modern meter department. Ill. 1700 w. Am Elect'n —Jan., 1899. No. 25570.

New Multiple Electric Hour-Meter. (Nouveau Compteur Electrique Horaire Multiple.) M. Aliamet. Illustrated description of the Cauderay meter, which is a clock meter with multiple circuits and a totalizing device. 2000 w. L'Electricien—Dec. 17, 1898. No. 25422 B.

Systems of Meter Rates. Edwin L. Debell. Read before the Northwestern Elec. Assn. Aims to show how the conditions of the electrical industry are affected by the system of rates employed, and considers what system will be just to customers and also improve the earnings. 3500 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25535.

The Practical Testing of Electricity Meters for Central Stations. C. A. L. Prusmann. Deals somewhat exhaustively with the process and methods of testing electricity meters. Considers the equipment of the meter-room, different types of modern meters, and testing. 2700 w. Elec Eng, Lond—Jan. 13, 1899. Serial. 1st part. No. 25514 A.

Voltameter.

A New Quicksilver Voltameter. (Ueber ein Neues Quecksilber-Voltameter.) Dr. L. Gurwitsch. The determination is effected by measuring the influence of the current on the volume of mercury flowing through a capillary aperture. 1500. Zeitschr f Elektrochemie—Jan. 5, 1899. No. 25449 H.

POWER APPLICATIONS.

Electric Launch.

A Design for an Electric Launch Motor. Charles T. Child. Illustrated description of a motor of simple construction which can be built at small cost. It is of a four-pole inclosed type, waterproof and intended to be attached

directly to the screw shaft. 4500 w. Sci Am Sup—Jan. 14, 1899. No. 25192.

Electric Lifts.

Electric Lifts for the New Brighton Eiffel Tower. Illustrates and describes an extensive system of lifts to be used in the highest tower yet built, to be constructed at a popular resort on the river Mersey. 1200 w. Engr, Lond—Jan. 6, 1899. No. 25271 A.

Electric Pumping.

See Mining and Metallurgy, Mining.

Motors.

Alternating Current Synchronous and Induction Motors. Ernst Julius Berg. On the construction and use of these motors, dealing in this part mostly with synchronous motors. 1500 w. Am Elect'n—Jan., 1899. No. 25567.

Mine Plant.

The Electric Plant of the Silesian Coal Mines at Gottesburg. (Die Elektrischen Anlagen der Schlesischen Kohlen- und Kokswerke zu Gottesburg.) Max Schmidt. An illustrated account of this extensive plant for underground lighting and pumping in the Silesian coal mines. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 24, 1898. No. 25463 D.

Power for Mills.

Power for Woolen Mills. C. J. H. Woodbury. Read at meeting of the Nat. Assn. of Wool Mfrs. Presents the advantages of electric transmission. 2500 w. Bos Jour of Com—Jan. 14, 1899. No. 25223.

Power Subdivision.

Domiciliary Electric Power Distribution in the St. Etienne Region. (Le Transport Electrique de la Force Motrice à Domicile dans la Région de St. Etienne.) Edouard Simon. A very complete description of the distribution of electric power among the ribbon weavers of the St. Etienne (France) district. There are 30,000 ribbon-looms, not grouped in factories, but mostly by twos and threes in the houses of workmen or small dealers. The distribution occupies 110 kilometres of lines, worked at 5,200 volts, three-phase. About 2,500 looms, each absorbing about ¼ h. p. are connected, and 8,000 incandescent lamps. The paper minutely describes the contract method of charging for power used by this installation. Ill. 3500 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25404 G.

Power Tests.

See Mechanical Engineering, Power and Transmission.

Speed Regulation.

Speed Regulation of Electric Motors. Allan D. Adams. Considers speed changes that originate in the motor. 900 w. Am Mach—Jan. 26, 1899. No. 25541.

Stage Mechanism.

Electrical Stage Mechanism at Drury Lane Theatre. Illustrates and describes some of the arrangements for remodelling this stage, especially describing two sections of the stage floor worked by electric power. 2000 w. Engng—Dec. 23, 1898. No. 25062 A.

TRANSMISSION.

Copper Economy.

Economy of Copper in Transmission Lines. Budd Frankenfield Assistance in determining the choice of a particular system of distribution, copper economy being the criterion of judgment. 1600 w. Wisconsin Engr—Jan., 1899. No. 25205 D.

Niagara-Buffalo.

The Use of Niagara Power by the Buffalo General Electric Company. Orrin E. Dunlap. Illustrated description of the new plant, its novel features of construction and apparatus. This is the most important application of electric power after a long transmission extant. 3000 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25173.

Three-Wire.

Conductors for the Three-Wire System. William Herbert Donner. Explains the saving of wire in the use of the three-wire over the two-wire system. 1100 w. Am Elect'n—Jan., 1899. No. 25568.

MISCELLANY.

Accounting.

Methods of Charging for Electricity in America. R. S. Hale and J. S. Codman. A brief account of the various methods in use in the United States for metering, discounts, contracts, etc. 1400 w. Elec Rev, Lond—Jan. 6, 1899. No. 25310 A.

Rate Schedules and Dividends. A consideration of the rate schedules of medium-sized plants and suggestions for more equitable methods. 2200 w. Can Elec News—Jan., 1899. No. 25257.

Electricians.

The Electrical Engineer. Editorial comment on a remark made in Mr. Preece's inaugural address, and prophesying that electrical engineers are destined to become known merely as engineers, a knowledge of electricity being understood to be a part of the necessary equipment of all bearing the name. A sensible and timely argument. 1500 w. Engng—Dec. 23, 1898. No 25150 A.

Legislation.

Recent Legistation in Relation to the Supply of Electricity for Light and Power. Frank Balfour Browne. A discussion of the effect of legislation on the development of the industry. 1800 w. Elec Rev, Lond—Jan. 6, 1899. No. 25307 A.

Review.

Electrical Engineering in 1898. A view of the year's progress in all the branches of electrical work, forming a portion of a general review of the engineering progress of the year. 4300 w. Engr, Lond—Jan. 6, 1899. No. 25272 A.

Shanghai.

Telephone and Tramway Systems in Shanghai. A statement of the conditions existing and the necessity of exercising care in bidding for tramway or other franchises. 1000 w. U. S. Cons Repts, No. 323—Jan. 13, 1899. No. 25225 D.

MARINE ENGINEERING.

Counterbalancing.

Studies upon Counterbalancing Marine Engines. (Alcuni Studi sul Bilanciamento delle Macchine a Vapore Marine.) A. Perroni. An elaborate mathematical paper, illustrated with diagrams. 11,000 w. Rivista Marittima—Dec., 1898. No. 25430 H.

Electric Launch.

See Electrical Engineering, Power Applications.

Ferry Boats.

The History of Ferry Boats. (Le Bac à Travers les Ages.) Daniel Bellet. Illustrated popular article. 1200 w. La Nature—Dec. 17, 1898. No. 25401 B.

The New Double-Screw Ferry Steamer "Berkley," of the Southern Pacific Co. Illustrated description of a large ferry steamer just put in service on the San Francisco Bay ferry-line, between the foot of Market St., San Francisco, Cal., and Oakland Pier. 500 w. Eng News—Dec. 29, 1898. No. 25946.

Ice-Breaking.

New Ice-Breaking Steamer for Russia. From the *Newcastle Daily Chronicle.* Describes the launch of an ice-breaking vessel, larger, heavier and more powerful than any yet built. Gives particulars and dimensions. 900 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25026 D.

Keels.

Cambered Keels. States the leading particulars of the case of Burrell v. Russell, which has excited much interest in England, and calls attention to erroneous views entertained in regard to the influence of cargoes upon a vessel's form. 2200 w. Engr, Lond—Jan. 13, 1899. No. 25390 A.

Launch.

Launch of the Oceanic. Full details of this vessel and the novel method of launching. Ill. 2500 w. Marine Rev—Jan. 19, 1899. No. 25362.

Management.

The Management of an Ocean Steamship Line. Franklin Matthews. A review of the work of various departments, showing the great executive ability required, the responsibility of those in charge, and many details of the work. 2800 w. Harper's Wk—Jan. 7, 1899. No. 25010.

Merchant Marine.

Merchant Marine of France. Points of interest upon the present condition. 1600 w. U. S. Cons Repts, No. 320—Jan. 10, 1899. No. 25145 D.

Our Foreign Merchant Marine. Frank J. Firth. Argument on the subject of United States shipping. 1200 w. Marine Rev—Jan. 12, 1899. No. 25227.

The Condition of the Italian Mercantile Marine. (Le Condizioni della Marina Mercantile Italiana.) Antonio Teso. An interesting statistical review of the status of Italian shipping, with many tables and data. 9000 w. Rivista Marittima—Dec., 1898. No. 25429 H.

Ocean Steamers.

The Manœuvring Power of Ocean Steamers. Information given by commanders of various vessels in reply to stated questions. 1700 w. Naut Gaz—Jan. 26, 1899. No. 25043.

Propellers.

The Basis of Propeller Design. J. Denholm Young. Read at meeting of the Liverpool Engng. Soc. Discusses the things that effect the performance of propellers. 2500 w. Steamship—Jan., 1899. No. 25138 A.

Propulsion.

Modern Steamship Propulsion. W. H. Atherton and A. L. Mellanby. Part first discusses the resistance and power of steamships. 2300 w. Prac Engr—Jan. 13, 1899. Serial. 1st part. No. 25508 A.

Slip and Its Relation to the Problem of Screw Propulsion. Edmund Leavenworth. Part first explains what slip is and the causes of variability. 2200 w. Marine Engng—Jan., 1899. Serial. 1st part. No. 25133 C.

Review of 1898.

Marine Engineering and Shipbuilding in the Year 1898 in the United Kingdom. A review of work in the different districts. 11,500 w. Engr's Gaz—Jan., 1899. No. 25139 A.

Shipbuilding.

A Problem in Shipbuilding. *From Illustrirte Zeitung.* Illustrations and brief description of the details of the work in lengthening the North German Lloyd Steamer "Spree," and transforming it from a single to a twin screw steamer. 1200 w. Sci Am Sup—Jan. 7, 1899. No. 25039.

New Vessels Being Constructed in United States Ship-Yards. A list with particulars of the vessels now under construction in the United States ship-yards, including both merchant and government work. 2400 w. Naut Gaz—Jan. 12, 1899. Serial. 1st part. No. 25209.

Shipbuilding in America. Editorial discussion of the competition that is inevitable in this industry and the prospects of success for the United States. 2200 w. Engng—Dec. 30, 1898. No 25154 A.

Thames Shipbuilding and Marine Engineering. A summary of the work, with tabular statement of the principal ships built by each firm. 3800 w. Engr, Lond—Dec. 30, 1898. No. 25157 A.

Signalling.

Signalling at Sea. (Le Segnalazioni in Mare.) Giuseppe Gavotti. An interesting article by a Vice Admiral of the Italian Navy, tracing the history of sea signalling from ancient times to the present. 9000 w. Rivista Marittima—Dec., 1898. No. 25428 H.

Steamboats.

Fast Side-Wheel Steamer. Illustrated description of the "Toronto," built at the Bertram Engine Works, for Richelieu & Ontario Navigation Co., for lake service. 1200 w. Marine

Rev—Jan. 12, 1899. No. 25226.

Robert Fulton and the Steamboat. Robert H. Thurston. On the amount of credit due to Fulton for the invention, and the claims of others. 1500 w. Sci Am—Jan. 21, 1899. No. 25342.

The Belgian Steamers of the Ostend-Dover Line. (Les Paquebots Belges de la Ligne Ostende-Douvres.) Daniel Bellet. A well-illustrated description of these fine boats. They have paddle-wheels, inclined compound engines, and make 22 knots. 6000 w. La Revue Technique—Dec. 25, 1898. No. 25408 D.

Steamships.

The Oceanic. Particulars concerning this vessel. It is the largest vessel yet built but does not aim to be the fastest, planning rather for uniformity in passage. 2000 w. Engr, Lond—Jan. 6, 1899. No. 25269 A.

The Union S.S. Co.'s New Steamer "German." Illustrated description of the latest vessel added to the line between England and Africa. 800 w. Steamship—Jan., 1899. No. 25137 A.

The White Star Liner "Oceanic." Editorial describing this largest vessel ever launched, and giving comparison with other notable vessels. 5500 w. Engng—Jan. 13, 1899. No. 25384 A.

Steering Gear.

The Harfield Steering Gear of the Italian Cruiser Carlo Alberto. (Meccanismo Harfield per il Timone della R. Nave Carlo Alberto.) An illustrated description of a steam steering gear of English origin, especially suited for naval vessels. 1800 w. 2 plates. Rivisita Marittima—Dec., 1898. No. 25431 H.

Submarine Boat.

Lake Submarine Boat "Argonaut." Illustrated detailed description of this vessel 1600 w. Elec Eng, N. Y.—Dec. 29, 1898. No. 24938.

I. Voyaging Under the Sea. Simon Lake. Illustrated account of the submarine boat "Argonaut" and her achievements. II. A Voyage on the Bottom of the Sea. Ray Stannard Baker. An illustrated account of an excursion in the "Argonaut." 7500 w. McClure's Mag—Jan., 1899. No. 24933.

Surveying.

Submarine Survey. Charles Bright. Part first considers the methods and appliances used in this work. Ill. 3000 w. Engng—Jan. 13, 1899. Serial. 1st part. No. 25380 A.

Water Tubes.

Fragmentary Remarks on the Water-Tube Boiler in Marine Work. William Burlingham. Discusses various types used in different countries, the sources of trouble, the reasons for their use, &c., &c. Ill. 300 w. Marine Engng—Jan., 1899. No. 25132 C.

MECHANICAL ENGINEERING.

AUTOMOBILISM.

Accumulator.

The Box and the Accumulator. (Le Coffret et l'Accumulateur.) H. Jarry. A discussion of the advantages of standardizing the batteries of electric automobiles and the cases containing them so that they would be interchangeable. 1300 w. Revue des Transports Parisiens—Dec. 1, 1898. No. 25425 D.

Electric Vehicles.

Electric Vehicles and Their Relations to Central Stations. Percy Maxim. Abstract of paper read before the Northwestern Elec. Assn. Considers the applications of these vehicles to practical purposes and the advisability of stations providing their plants with the apparatus necessary to charge them. 3300 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25536.

The Milde Electric Voiturette. A brief illustrated description of a novel automobile. 300 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25534.

Exposition.

The Exposition of Automobiles at the Tuileries, Paris. (L'Exposition des Automobiles des Tuileries.) M. Barbet. A description of the vehicles exhibited, with 57 illustrations. 7000 w. Rev de Mecanique—Dec., 1898. No. 25426 H.

Gearing.

A Hydraulic Variable Speed Gearing. An illustrated description of a patent of Mr. Hall and the important points secured. 1300 w. Engr, Lond—Jan. 19, 1899. No. 25394 A.

HYDRAULIC ENGINEERING.

Contractor's Plant.

A Hydraulic Sand Plant. Illustrates and describes a method of dredging, transporting and washing sand by water. 1000 w. Eng Rec—Jan. 21, 1899. No. 25354.

Fluid Motion.

Further Experiments on the Character of Fluid Motion. H. S. Hele-Shaw. Read before the Liverpool Engineering Soc. Illustrated description of recent results of experimental study. 9000 w. Engng—Jan. 6, 1899. No. 25286 A.

Pump Action.

Suction or Pressure? Considers the principle which underlies the mode of action of pumps, siphons, barometers, &c. 2000 w. Mines & Min—Jan., 1899. No. 25114 C.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings. C. R. Gerrard. A discussion of some of the important features of anti-friction bearings as they stand at present. Ill. 2500 w. Mech Engr—Dec. 24, 1898. No. 25219 A.

End-Trust Ball Bearings. Thomas Hill. A report of investigations and conclusions. Ill.

800 w. Am Mach—Jan. 5, 1899. No. 25083.

Fundamental Facts Relating to Ball Bearings. Reynold Janney. Illustrated discussion of fundamental principles. 2000 w. Am Mach—Jan. 5, 1899. No. 25084.

Boring Machine.

Double Boring and Milling Machine. (Doppelte Bohr-und Fräsmachine.) An illustrated description of a large boring machine, designed by the Oerlikon Machine Works, and especially adapted for electrical work. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 25472 D.

Brass Bushes.

Fitting Brass Bushes. F. H. Directions for the turning and insertion of bushes, and the care necessary with the larger sizes. Ill. 1500 w. Mech Wld—Dec. 23, 1898. No. 25045 A.

Caliper.

A New Form of Contour Caliper. W. F. Durand. An instrument devised to determine whether or not the contour or cross section of a pin, axle or spindle is circular, and if not the finding where it departs from the true or circular outline. Illustrated description. 1700 w. Sib Jour of Engng—Jan., 1899. No. 25396 C.

Center Plates.

A Study in Center Plates. George L. Fowler. Discusses design and choice of material, and recommends a form of plate that may be adopted as a standard. Ill. 3300 w. R R Car Jour—Jan., 1899. No. 25229.

Dies.

Die Construction. George B. Painter. An explanation of methods and rules to be observed. Ill. 2200 w. Am Mach—Jan. 5, 1899. No. 25082.

Foundry Iron.

The Purchase of Foundry Iron on Analysis and a Standard System of Grading Pig Iron. A circular letter was sent out with the view of ascertaining the sentiment of foundrymen, and the first twenty replies are given in part first. 2300 w. Am Mfr & Ir Wld—Jan. 13, 1899. No. 20245.

Gears.

A Gear Trimmer. A. H. Cleaves. Illustrates and describes a device used in retouching small brass gears, which the writer believes would be very useful in similar work. 700 w. Mach, N. Y.—Jan., 1899. No. 25595.

Grinding.

Bicycle Cup and Cone Grinding Machines. Illustrates and describes some novel machines recently developed by the Pratt & Whitney Co., of Hartford, Conn. 1600 w. Am Mach—Jan. 12, 1899. No. 25181.

Gun Boring.

Boring a Thirteen-Inch Naval Gun. E. J. Prindle. Illustrates and describes the boring of this tube of a thirteen-inch breech-loading rifle at the Naval Gun Factory at Washington, D. C. 1000 w. Am Mach—Jan. 26, 1899. No. 25537.

Machine Tools.

A New Method of Boring, Milling, and Tapping Machine Frames by Use of Templates. E. Capitaine. From the *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrates and describes a special portable tool. 2000 w. Ir Age—Jan. 26, 1899. No. 25525.

English and American Machine Tools. Extracts from a discussion in the London *Engineer* as to the relative merits of British and American tools. 5500 w. Ir Age—Jan. 26, 1899. No. 25526.

Machinists' Hardware.

See Economics and Industry, Commerce and Trade.

Melting Iron.

Experiments in Melting Iron. Edward Kirk. From advance sheets of a work on "Cupola Practice" soon to be issued. Further experiments are described and results given. 2500 w. Ir Trd Rev—Jan. 19, 1899. No. 25398.

Molding.

Molding a 30-Inch Check Valve in Loam. Arch. Landon. Illustrates and describes the method employed in the molding. 800 w. Foundry—Jan., 1899. No. 25320.

Molds. Warren E. Willis. Practical points of interest about molding, including casting, drop forging, coining, compressing, embossing, &c. 2500 w. Mach, N. Y.—Jan., 1899. Serial. 1st part. No. 25596.

Patching.

Mending Holes in Retorts. R. D. Moore. Describes manner of patching castings by "melting on." 900 w. Foundry—Jan., 1899. No. 25321.

Planer.

Machine For Planing Armor Plates. (Hobelmaschine zur Bearbeitung von Panzerplatten.) L. M. Schechter. A brief description of powerful planing machine constructed by the Charkow Machine Works, Russia, for use in the Russia naval workshops at Kolpina, near St. Petersburg, with plate of working drawings. 800 w. 1 plate. Zeitschr d Ver Deutcher Ing—Dec. 31, 1898. No. 25465 D.

Ratchet Drill.

The Making of a Ball-Bearing Ratchet Bit Brace. Illustrates and describes the methods connected with the manufacture of this brace as carried out at Plantsville, Conn. 2400 w. Ir Age—Jan. 5, 1899. No. 25014.

Shop Practices.

Electrical and Repair Shop Practices in Philadelphia. Illustrated description of the rearranged cables since the consolidation of the different companies, resulting in economy of current and copper, and facilitating examination. Also describes other improvements. 1000 w. St Ry Jour—Jan., 1899. No. 25304 D.

Special Work.

Special Operations in Large Electrical Works. Illustrates and describes some methods followed at the works of the Westinghouse Electric & Manufacturing Co. 1400 w. Am Mach—Jan. 19, 1899. No. 25337.

Tanks.

Cast-Iron Tanks. P. Hutchison. Informa-

tion aiming to enable any draughtsman to design a cast-iron tank without having any previous knowledge of the subject. Ill. 700 w. Prac Engr—Dec. 30, 1898. No. 25148 A.

Tools.

Compressed Air Hose Tools. B. G. Miller. Illustrations and description of machines especially useful in doing the work on air hose and the pipes connected with the air-brake system. They are in use at the Fort Madison shops of the A., T. & St. F. Ry. 900 w. R R Car Jour —Jan , 1899. No. 25230.

Tool Works.

Herbert's Machine-Tool Works. Describes and illustrates these well-planned works, designed for the production of machine tools. 2800 w. Engng—Dec. 30, 1898. No. 25151 A.

Tubes.

The Production of Metallic Tubes by Extrusion. Illustrates and describes the system invented by Alexander Dick. 1800 w. Engng —Jan. 6, 1899. No. 25283 A.

Type Dovetailing.

A Type Dovetailing Job. Walter Gribben. Describes the inserting of some printers' type in the periphery of a tool steel wheel. Ill. 1400 w. Am Mach—Jan. 26, 1899. No. 25540.

Wood Working Machinery.

The Development of Wood-Working Machinery. John Richards. The first article of a series which will describe the growth of the now-working industry, the evolution of its machinery, and the present condition of the art. This installment is devoted to the general subjects of cutters and blades, and the development of the planer. Illustrated. 5600 w. Engineering Magazine—Feb., 1899. No. 25435 B.

Workmanship.

Good Workmanship. Editorial on the waste of time and labor in giving high finish when it adds neither to beauty or efficiency, considering it immoral. 1600 w. Engng—Jan. 6, 1899. No. 25284 A.

Works Management.

Machine-Shop Management in Europe and America. H. F. L. Orcutt. This paper, the second of a series, treats of labor-saving machinery, as exemplified in American works, and low-wage workmen, and contrasts the output and earning power of works equipped with high-class machinery and few men with those using many inferior men and poor tools. 3800 w. Engineering Magazine—Feb., 1899. No. 25433 B.

The Depreciation of Plant and its Relation to General Expense. H. M. Norris. A consideration of the practice of a number of metal working establishments in cost-keeping, with reference to charges for depreciation of machines. 4300 w Engineering Magazine—Feb., 1899. No. 25441 B.

MATERIALS OF CONSTRUCTION.

Specifications.

The Coolgardie Steel Pipe Contract. A copy of the specifications and comment on the many-sided contract. 2000 w. Ir & Coal Trds Rev —Jan. 13, 1899. No. 25377 A.

Testing.

Prof. Martens on Testing Cast Iron. Dr. R. Moldenke. Presents the views of Prof. Martens with comments. 2500 w. Ir Trd Rev—Jan. 19, 1899. No. 25397.

Test Samples.

Standardizing Methods of Testing Metals. (Uniformisation des Méthodes d'Essais des Métaux.) Short abstract of a paper read before the Société Industrielle de l'Est by M. Baclé. An argument for interational standards in sizes and proportions of test pieces and methods of testing. 1000 w. Le Génie Civil—Dec. 17, 1898. No. 25412 D.

POWER AND TRANSMISSION.

Air Compression.

The Two-Pipe System of Air Compression. A. E. Chodzko. Considers the advantages claimed for it over the single-pipe system. 4400 w. Mod Mach—Jan., 1899. No. 25170.

Belting.

The Horse-Power of Belting. Rules for computing the horse-power which can be safely transmitted by a given belt, &c. 1000 w. Power —Jan., 1899. No. 25093.

Cable Hoist.

The St. Paul Cable Hoist. Illustrates and describes the conveyor plant recently built for the U. S. government at St. Paul, Minn. It solves the problem of dispensing with fall-rope carriers, which have heretofore been necessary for supporting the hoisting rope. 1000 w. Stone—Dec., 1898. No. 24935 C.

Coal-Handling.

Coal-Handling Machinery. Charles Piez. A discussion of continuous coal-handling machinery, under the two heads of elevators and conveyors. Ill. 4200 w. Pro of Engs' Club of Phila—Jan., 1899. No. 25176 D.

Coal Hoists.

The Coal Hoists of the Calumet and Hecla Mining Company. Julius Kahn. An illustrated description of the plant erected by this company at Lake Linden, Mich., and of its operation. 5500 w. Pro Am Soc of Civ Engs —Dec., 1898. No. 24934 F.

Compressors.

Automatic Air Compressors Adapted for Electric Motors. Illustrates and describes the Rix variable volume air compressor being installed at the North Star mine at Grass Valley, Cal. 1200 w. Min & Sci Pr—Dec. 31, 1898. No. 25079.

Cone Pulleys.

The Computation of Cone Pulleys for Machine Tools. (Zur Berechnung der Stufenscheiben für Werkzeugmaschinen.) Heinrich Weiss. An analytical and graphical discussion of the problem, resulting in general equations, and diagrams adapted for the proportioning of cone pulleys for lathes and similar machines. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 23, 1898. No. 25475 B.

Gears.

Table of Strength of Gears. John Fitch.

Gives a table for calculating the proper dimensions of gearing. 1000 w. Am Mach—Jan. 19, 1899. No. 25338.

Power Plants.

Finance and Economics of Power Plants. R. H. Thurston. A detailed study of this subject. 1800 w. Engr, U. S. A.—Jan. 1, 1899. Serial. 1st part. No. 25143.

Power Tests.

Power Tests of Motor Driven Machines. L. E. Lemon. Describes arrangements and methods of testing under various conditions. 2000 w. Mod Mach—Jan., 1899. No. 25169.

Shafting.

Diagrams for the Design of Shafts. G. Eugene Barrett. Diagrams with an explanation of their use. 600 w. Am Mach—Jan. 12, 1899. No. 25182.

SPECIAL MOTORS.

Diesel Motor.

Tests of a Diesel Motor. Condensed report by James E. Denton, of a series of economy tests, using various kinds of oil as fuel. Describes the motor and gives results. 2300 w. Eng News—Dec. 29, 1898. No. 24951.

Gasoline Motor.

A New Gasoline Motor. From *La Nature*. Illustrates a motor and carbureter and explains the process by which it manufactures its supply of gas for itself. 1200 w. Sci Am Sup—Jan. 14, 1899. No. 25193.

Oil Engines.

The Oil Engine for Motor Cars. Considers the oil engine as it is and as it ought to be, chiefly with view to its application to self-propelled vehicles, 2800 w. Engr, Lond—Jan. 6, 1899. Serial. 1st part. No. 25268 A.

Petroleum Motor.

Petroleum Power Engine. (Petroleum-Kraft-Machine.) E. Capitaine. Illustrating and describing Capitaine's improved petroleum motor, with very complete exhibition of details, showing much ingenuity of design. 4500 w. Zeitschr d Ver Deutscher Ing—Dec. 31, 1898. No. 25466 D.

Producer Gas.

Direct Utilization of Producer Gas in Europe. E. P. Buffet. Abstract of a review of the results as far as known that have been obtained in Europe with the use of producer gas in gas engines, as given by Aug. Dutreux, in *Le Génie Civil*. 2500 w. Am Mach—Jan. 26, 1899. No. 25538.

STEAM ENGINEERING.

Blowing Engines.

Compound Blowing Engines. Illustrates and describes a pair of vertical cross-compound blowing engines. 1400 w. Engng—Jan. 6, 1899. No. 25282 A.

Boiler.

The Steam Boiler and Its Safety. F. G. Mitchell. Read before the Hamilton Assn., C. A. S. E. Calls attention to some points affecting the safety of boilers. 1000 w. Can Elec News—Jan., 1899. No. 25258.

Boiler Explosion.

A Noteworthy Boiler Explosion. Gives in full the report of the Board of Trade relating to the explosion of a boiler at St. George's, Bridge Street, Norwich, Eng. 5500 w. Engr, Lond—Dec. 23, 1898. No. 25068 A.

Boiler Explosion at Barking. An account of an extremely violent explosion, accompanied by loss of life. The first recorded instance of the accidental explosion of the shell of a "Scotch" boiler. Illustrations and editorial. 2800 w. Engr, Lond—Jan. 13, 1899. No. 25393 A.

Boiler Testing.

Notes on Testing Steam Boilers. Frederick Grover. The notes refer to such tests as are necessary to determine the economic performances. 2000 w. Mech Wld—Jan. 6, 1899. Serial. 1st part. No. 25299 A.

Counterbalancing.

See Marine Engineering.

Cylinder Ratios.

Cylinder Ratios for Compound Engines. George I. Rockwood. Read before the Providence Assn. of Mech. Engs. A discussion of the merits of large ratios. 6000 w. Eng Rec—Jan. 7, 1899. No. 25103.

The Computation of Triple Expansion Engines. (Die Berechnung und Dimensionirung der Dreifach-Expansionsmachinen.) J. Illeck. An elaborate application of the author's graphical method to the determination of cylinder ratios for triple expansion steam engines. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 16, 1898. No. 25473 B.

The Determination of Cylinder Sizes. J. C. Cornock. A study of the considerations affecting the sizes of cylinders, the effect of compounding, &c. 3000 w. Mech Engr—Dec. 24, 1898. No. 25220 A.

The Graphical Computation of Multiple Cylinder Engines. (Die Graphische Berechnung Mehrcylindriger Dampfmaschinen.) J. Illeck. Giving a graphical diagram from which the proper cylinder ratios may be determined for given conditions. 1500 w. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 23471 D.

Economy.

Economy of Steam Production. A. L. Harrison. Considers the boiler and appurtenances, and boiler-room practice. 1700 w. Am Elect'n Jan., 1899. No. 25571.

Improvement in the Economy of the Steam Engine. W. F. Durand. A study of the thermal efficiency of the engine, and the various conditions upon which it depends. 1700 w. Am Elect'n—Jan., 1899. No. 25565.

Engine Test.

Test of an Allis Pumping Engine at St. Paul, Minn. Reports a 72-hour test of an engine at the McCarron Lake pumping station, and the satisfactory results. 800 w. Eng News—Dec. 29, 1898. No. 24950.

Feed Water.

Feed Water Filters. A. E. Shute. An il-

lustrated description of such examples as seem most important and popular. 3600 w. Col Guard—Dec. 30, 1898. No. 25160 A.

Governors.

Steam Engine Governors. John Davidson. Read before the Salford Science Students' Assn. Part first discusses the throttle and variable expansion governors, quoting from various writers. 1800 w. Prac Engr—Jan. 6, 1899. Serial. 1st part. No. 25305 A.

High-Speed Engines.

High-Speed Engines. J. H. Dales. Read at meeting of British Inst. of Civ. Engs. Abstract of paper stating that the ordinary rates of rotation could with impunity be exceeded to the extent of 30 to 50 per cent. by the application of an adjustment of bearing brasses; also gives suggestions on good governing. 1300 w. Ir & Coal Trds Rev—Jan. 13, 1899. No. 25378 A.

Plugs.

Fusible Plugs. An explanation of their mechanism and why they burn out. 1000 w. Bos Jour of Com—Jan. 14, 1899. No. 25224.

Pumping.

An Engine Builder's View of Present Pumping Practice. Reviews a paper by Irving H. Reynolds, of the Edward P. Allis Co. 3000 w. Eng Rec—Jan. 21, 1899. No. 21357.

Test of a Steam Pumping Engine. Gives the results of a test of a 5,000,000-gal compound fly wheel pump. 450 w. Eng Rec—Jan. 21, 1899. No. 25356.

See Municipal Engineering, Water Supply.

Reaction.

The Reactive Influence of Steam. W. J. M. Considers the reactive influence of a fluid, such as steam, in producing motion, when the steam flows into the atmosphere. 1000 w. Engr, Lond—Jan. 6, 1899. No. 25270 A.

Saturated Steam.

Concerning Regnault's Calorie and Our Knowledge of the Specific Volumes of Steam. G. P. Starkweather. Reviews experiments with superheated steam, noting discrepancies and concluding that knowledge concerning the density of steam is limited to the saturation line. 7200 w. Am Jour of Sci—Jan., 1899. No. 24976 D.

Scale.

The Effect of Scale on the Evaporation of a Locomotive Boiler. L. B. Breckenridge. Gives details of a series of tests recently completed at the Univ. of Illinois. 1400 w. R R Gaz—Jan. 27, 1899. No. 25555.

Smoke.

Competition for the Suppression of Smoke Produced by Boiler Furnaces in Paris. (Concours de la Ville de Paris pour la Suppression des Fumées Produites par les Foyers des Chaudières à Vapeur.) This most important review of the tests made by the city of Paris of various smoke-suppressing devices goes at great length into details of tests and conclusions reached. Fully illustrated. 38,000 w. Rev de Mecanique—April, June, Sept., and Dec., 1898. No. 25428, each H.

The Prevention of the Emission of Dense Smoke in Cities and in Other Places. Reviews methods devised for the prevention of smoke emission, and describes the "Lowe" smoke preventer, which is considered the most simple, least costly, and most efficient device yet invented. Ill. 8400 w. Ind & Ir—Dec. 23, 1898. No. 25055 A.

Steam.

Steam Consumption. Editorial comment on a paper by R. A. Ziese in *Zeitschrift des Vereins Deutscher Ingenieure*, dealing with vertical v. horizontal engines for stationary purposes, insisting that maximum efficiency can only be obtained with the vertical engine. 2000 w. Engng—Jan. 13, 1899. No. 25383 A.

Testing.

Engine and Boiler Testing. Henry W. Spangler. On the value of commercial testing and the methods of making the tests. The subject is discussed in detail. 6300 w. Pro of Engs' Club of Phila—Jan., 1899. No. 25-177 D.

Theory.

The Mathematical Theory of the Steam Engine (Principes de la Théorie Mathématique de la Machine à Vapeur.) J. Nadal. An elaborate treatise and review of existing theories. 18,000 w. Rev de Mecanique—Nov. and Dec., 1898. No. 25427 each H.

Valves.

How to Set Valves. Ira A. Moore. Gives careful directions showing that there is nothing very perplexing in the work. 4000 w. Loc Engng—Jan., 1899. No. 25000 C.

Waste Heat.

Utilization of the Waste Heat from Coke Ovens. M. Soulary. From a communication to the Société de l'Industrie Minerale. A record of results obtained in current working. Concludes that a well-designed water-tube boiler gives as good a yield as one of multitubular type, without the many disadvantages, and that it affords a greater measure of safety. Ill. 7500 w. Col Guard—Jan. 6, 1899. No. 25-290 A.

MISCELLANY.

Engineers.

A Talk to Young Engineers. W. A. Truesdell. On the present opportunities for acquiring an education, and its advantages to the engineer; the qualifications needed and the conditions of success. 8000 w. Wisconsin Engr—Jan., 1899. No. 25201 D.

The Status of the Engineer. J. S. Walker. Abridged address of the president of the Engineering Assn. of the South, delivered at Nashville, Tenn. 2700 w. Am Mach—Jan. 12, 1899. No. 25183.

Pumps.

Driving Pumps by Compressed Air. William Cox. Presents the conditions which must be fulfilled so that the best results may be obtained. 1000 w. Compressed Air—Jan., 1899. Serial. 1st part. No. 25135.

Refrigeration.

A Series of Tests of the Refrigerating Plant in the Steam Engineering Laboratory of the University of Wisconsin. Walter Alexander, William H. Kratsch, Wallace F. Macgregor. Briefly reviews the history of ice-making from the earliest times, and the refrigerating systems and machines, giving the results of a series of tests conducted to determine the comparative efficiencies, with pressures varying from 140 to 220 pounds. 3500 w. Wisconsin Engr—Jan., 1899. No. 25204 D.

Electrical Equipment of a Modern Refrigerating Plant. An illustrated description of the refrigerating plant of the Manhattan Refrigerating Co, in New York city. 3000 w. Am Elect'n—Jan., 1899. No. 25561.

Practical Tests. Alfred Siebert. Discussing the making of approximate tests by the engineer with appliances at hand, to determine the results of the coal used, and the work of pumps, engines and refrigerating machines. 2700 w. Ice & Refrig—Jan., 1899. Serial. 1st part. No. 25017 C.

The Cincinnati Oyster and Fish Co. Illustrates and describes the modern, up-to-date plant of the Triumph Ice Machine Co. 2500 w. Ice & Refrig—Jan., 1899. No. 25016 C.

The Refrigerating Plant in the City Markets of Vienna. (Die Kühlanlage in der Städtischen Grossmarkthalle in Wien.) Joh. Hermanek. A full account of the manner in which a uniformly low temperature is maintained in the vaults of the market at Vienna, by the forced circulation of cooled air. Zeitschr d Oesterr Ing u Arch Ver—Jan. 6, 1899. No. 25479 B.

Review.

Mechanical Engineering. The annual editorial review of this branch reports a very uneventful year and gives some of the reasons-5200 w. Engr, Lond—Jan. 6,1899. No. 25275 A.

MILITARY ENGINEERING.

Battleships.

A New Russian Battleship. Illustration and dercription of the vessel being built at the shipyard of Messrs. Cramp & Co., Philadelphia, U. S. A. 1500 w. Engr., Lond--Dec. 30, 1898. No. 25158 A.

The Battleships of 1899. Illustrated description of the five fine vessels now being completed in American ship-yards. 2500 w. Naut Gaz—Jan. 5, 1899. No. 25096.

British Navy.

British Naval Progress. Gives information concerning the new work to be given out by the Admiralty to private contractors, and reviews the progress made with warship building. 2800 w. Engng—Dec. 23, 1898. Serial. 1st part. No. 25061 A.

The British Navy. A review of the British navy, noting its best features, and also its defects. 3400 w. Ill Car & Build—Jan. 6, 1899. No. 25298 A.

Destroyer.

The Torpedo-Boat Destroyer "Ikadsuche" for the Imperial Japanese Navy. Report of the preliminary trial giving reproduction of a photograph taken when the vessel was traveling over 31 knots. 450 w. Engng—Dec. 30, 1898. No. 25152 A.

Fire-proofing Wood.

A Process of Fire-proofing Wood to Be Used for the Woodwork of War Vessels. C, J. Hexamer. Describes process of impregnating the wood with soluble glass. 2000 w. Jour Fr Inst—Jan., 1899. No. 25128 D.

Guns.

Siege Guns at the Washington Arsenal. Illustrations of two types of siege guns, with particulars. 800 w. Sci Am—Jan. 21, 1898. No. 25341.

The Test of the Gatling Cast Steel 8-Inch Gun. Report of Dr. John N. Stockwell of an investigation of the effects of cooling on the strains of the different parts of the gun. 1400 w. Sci Am Sup—Jan. 21, 1899. No. 25344.

Maxim Guns.

The Tactical Applicability of the Maxim Machine-Gun. A. v Boguslawski, in *Kriegstechnische Zeitschrift.* Concludes the guns adapted to the uses of cavalry but of doubtful effect when employed by infantry. 2500 w. Sci Am Sup—Jan. 14, 1899. No. 25194.

Naval Engineering.

The War's Teaching in Naval Engineering. George W. Melville. The topics specially discussed are the importance of coal, water, repair-ships, uniform design of machinery, water-tube boilers, triple screws, speed, tests and training. The highest praise is given the personnel of the engineers corps. 4000 w. Stevens Ind—Jan., 1899. No. 25523 D.

Naval Experience.

Readings from Experience in Naval Engineering. George W. Melville. A review, by the Engineer in Chief of the United States Navy, of the lessons learned in the engineer's department by experience in the recent war with Spain. It is full of information, hitherto unpublished, of great interest. Serial. 1st part. 3500 w. Engineering Magazine—Feb., 1899. No. 25432 B.

Naval History.

Naval History of the United States of America. Part first reviews the earliest history of the U. S. Navy to the breaking out of the revolutionary war. 2500 w. Naut Gaz—Jan. 5, 1899. Serial. 1st part. No 25097.

Ordnance Factories.

The Management of Ordnance Factories.

Editorial discussion of the question of civil as against military control. 2200 w. Engng—Dec. 30, 1898. No. 25153 A.

Sheathing.

Sheathing Warships. G. E. Walsh. Considers the advisability of using copper sheathing, discussing the objections, and giving the experience of other nations. 1200 w. N Am Rev—Jan., 1899. No. 24980 D.

Soudan Campaign.

Gunboats and Railways in the Soudan Campaign. Iilustrates and describes these gunboats and the method of conveying them by rail around impassable rapids. 1200 w. Sci Am—Jan. 14, 1899. No. 25191.

War Material.

War Material. Editorial review of the progress made during 1898, and the lessons learned from the Spanish-American war. 1800 w. Engr, Lond—Jan. 6, 1899. No. 25279 A.

Weapons.

The Shot-Gun, Its Origin, Evolution and Present Status. (Le Fusil de Chasse, son Origine, ses Transformations, sa Situation Actuelle.) Report by M. E. Polonceau to the Société d'Encouragement pour l'Industrie Nationale upon the work of M. Nouvelle. Interesting data of the development of fire-arms, with statistics of the present French import and export trade in guns. 1300 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25402 G.

MINING AND METALLURGY.

COAL AND COKE.

American Coal.

See Economics and Industry, Commerce and Trade.

Anthracite.

Anthracite Mining During 1898. A history of the progress in Pennsylvania and of the efforts to overcome trade difficulties. 2200 w. Mines & Min—Jan., 1899. No. 25124 C.

Mining Anthracite. A letter from W. S. Gresley containing suggestion for improved method of taking out all the coal on heavy pitches. Ill. 900 w. Mines & Min—Jan., 1899. No. 25113 C.

Briquettes.

Coal Briquettes in Wales. An account of this industry which is conducted on an extensive scale. 2000 w. U. S. Cons Repts, No. 327—Jan. 18, 1899. No. 25325 D.

British Coal.

The Coal Trade in 1898. Report of Northumberland, Durham, Lancashire, Yorkshire, Derbyshire and Nottinghamshire, South Staffordshire, South Wales and Monmouthshire, Scotland, and London. 8500 w. Col Guard—Jan. 6, 1899. No. 25288 A.

Coal Consumption.

Consumption of Coal for Steam at the Anthracite Collieries. A. D. W. Smith. Statistics are given showing that the Wyoming region, in 1897 used coal for steam amounting to 7 per cent. of its marketed product, and the balance of the region used 14 per cent. 1200 w. Eng & Min Jour—Jan. 21, 1899. No. 25363.

Coal Mining.

Indiana, Illinois, and Iowa Coal Mining in 1898. Hugh Murray. The condition of the business and the arrangement of scale of wages with the miners. 2000 w. Mines & Min—Jan., 1899. No. 25118 C.

Coal Testing.

Tests of Coal for Locomotives. William Garstang. Extracts from a paper read at the Dec. meeting of the Western Ry. Club. On the mode of procedure and results obtained from road tests on Big Four Ry., and from laboratory tests conducted at Purdue Univ. 2300 w. Ry & Engng Rev—Jan. 14, 1899. No. 25267.

Coal Working.

Systems of Working Coal. J. T. Beard. Conditions which determine the system by which a field should be worked. Modifications of the two general systems of extraction, making these systems applicable to all conditions of roof, floor, coal, depth, inclinations, clearage, gas, etc. Ill. 3500 w. Mines & Min—Jan., 1899. Serial. 1st part. No. 25106 C.

Coke and Briquettes.

Domestic Coke and Briquettes from Retort Coke Ovens. R. M. Atwater. Read at meeting of the Ohio Inst. of Min. Engs. Discusses the prospect of using Ohio coals for blast furnace coke; the effect of fine grinding, the retort oven coke, with details of the operation, and the making of briquettes. 3300 w. Ir Trd Rev—Jan. 26, 1899. No. 25592.

Coke Manufacture.

The Manufacture of Coke. A detailed consideration of the systems of importance now used in England, dealing with the results obtained. This article presents the Otto system. Ill. 2800 w. Col Guard—Jan. 13, 1899. Serial. 1st part. No. 25387 A.

Coking.

Coking Lean Coals with the Aid of Mechanical Stamping Appliances. Oscar Simmersbach, in *Stahl und Eisen*. An interesting review of the mechanical appliances used in Germany, with the aim of hardening coals relatively low in bituminous matter. Ill. 2800 w. Ir Age—Dec. 29, 1898. No. 24963.

Colliery Sinking.

An Account of the Maypole Colliery Sinking, Wigan. A. H. Leech. Abstract of a paper read before the British Assn. of Mining Students. Explains the conditions prevailing in this locality, and describes the sinking, which was a very difficult work. Ill. 3000 w. Ir & Coal Trds Rev—Jan. 13, 1899. No. 25379 A.

Comparison.

Charcoal and Coke. Notes wherein they resemble and differ from each other. Cleavage in coke and metals. Ill. 1500 w. Mines & Min—Jan., 1899. No. 25108 C.

Dakota.

Coal in North Dakota. E. J. Babcock. A description of the extent and location of the formations and the various qualities of the coal. 1000 w. Mines & Min—Jan., 1899. No. 25110 C.

Miike Coalfield.

The Miike Coalfield and the Largest Collieries in the East. States the general conditions existing in Japan, and considers the more important coal-fields. 7500 w. Ir & Coal Trds Rev—Jan. 6, 1899. No. 25287 A.

Ohio.

Jackson County Coal Mines. Andrew Roy. The development of a high-grade Ohio coal field and a history of its exploitation. 1000 w. Mines & Min—Jan., 1899. No. 25111 C.

Saint-Eloy Colliery.

Incline for Large Output at the Saint-Eloy Colliery. M. H. de Lachapelle. Communicated to the Société de l'Industrie Minérale. Illustrates and describes a new incline with carrying truck of special type. 2000 w. Col Guard—Dec. 23, 1898. No. 25056 A.

Scotch Coals.

Chemical Notes on Scotch Coals. W. C. Anderson. Abstracted from the Proceedings of the Glasgow Philosophical Soc. Describes the varieties, gives an estimate of the coking power, oxidation, and the effect of heat. 2400 w. Gas Wld—Jan. 14, 1899. No. 25510 A.

Sizing.

The Effect of Sizing on the Removal of Sulphur from Coal by Washing. Charles C. Upham. Calls attention to an element in the preliminary treatment, which is very generally neglected in the washing of coal, and of importance in coke-making. 1400 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24972 D.

Washington.

Coal Mines of Washington. A description of the mines at Carbonado, Wilkeson and Burnett, in Pierce County. The peculiarities of the formation in which the coal is found and some instances in which advantage has been taken of them in mining the coal. Ill. 2200 w. Mines & Min—Jan., 1899. No. 25112 C.

Western Coal.

Data as to the Value of Western Coal. Tabulated statement of the principal results of government tests, with analyses of a number of coals. 500 w. R R Gaz—Jan. 13, 1899. No. 25214.

COPPER.

Copper.

See Electrical Engineering, Electrochemistry.

Copper Market.

Boom in Copper Market. On the present condition of the copper market, giving articles reprinted from the *N. Y. Sun* and *N. Y. Tribune*. 2000 w. W Elect'n—Jan. 14, 1899. No. 25252.

Mine.

Peak Downs Copper Mine. From the *Brisbane Courier*. An account of the reopening of a mine worked with much success many years ago. 1100 w. Aust Min Stand—Dec. 15, 1898. No. 25302 B.

Wyoming.

Wyoming Copper. E. P. Snow. Brief review of the districts known to be rich in copper within the limits of this State. 1200 w. Min Rept—Dec. 29, 1898. No. 25020.

GOLD AND SILVER.

Australia.

The Alluvial Deposits of Western Australia. T. A. Rickard. Describes the geology and physiography of these gold fields, distribution, dry blowing machinery, water supply and theories of the origin of the deposits. Ill. 9900 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24967 D.

California.

The Mother Lode of California. Arthur Lakes. A description of what is supposed to be the largest vein system in the world. Its location, position, and extent; the peculiarities of its formations and the various kinds and qualities of the minerals. Ill. 4200 w. Mines & Min—Jan., 1899. No. 25107 C.

Colorado.

The Silver Pick Mine—Wilson, Colorado. M. B. Spaulding. A sketch of a mine presenting many novel features. 2800 w. Sch of Mines Qr—Nov., 1898. No. 25198 D.

Concentration.

Concentration After Lixiviation. Mall. W. Anderson. On the treatment of tellurium ores in the cyanide mills treating the refractory ores of the mines of Cripple Creek and vicinity. 1100 w. Min & Sci Pr—Dec. 31, 1898. No. 25080.

Deep Leads.

Victorian Deep Leads. Information of a comprehensive boring scheme, with brief accounts of the districts in which it is proposed to search for deep leads. 2000 w. Aust Min Stand—Nov. 24, 1898. No. 25042 B.

Fire Assaying.

Remarks on Fire Assaying of Gold-Bearing Materials. William Bettel. Discusses the losses of gold, collection of finely divided gold, and other points which affect the accuracy of results. 4500 w. Jour of Chem & Met Soc of S Africa—Nov., 1898. No. 25296 E.

Hauraki Goldfields.

Water-Supplies for Mining Townships on the Hauraki Goldfields. Recommendations of T. Perham, for supplying water for domestic uses and fire-extinction. 6500 w. N Z Mines Rec—Dec. 16, 1898. No. 25303 B.

Idaho.

Gold Mining at Gibbonsville, Idaho. Don

Maguire. Facts in regard to the history and prospects of an interesting mining town. 1800 w. Mines & Min—Jan., 1899. No. 25117 C.

Milling.

Milling of Rossland Ores. H. W. C. Jackson. A description of the British Columbia Bullion Extracting Company's Pelatan-Clerici Cyaniding plant. 1200 w. Can Min Rev—Dec. 31, 1898. No. 24996 B.

Mill Practice.

Mill Practice of the Utica Mills, Calaveras County, California. A description of the present practice in these mills. 5500 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24968 D.

Placer Gold.

Origin of Placer Gold in the Drains of the Divide. A. M. Welles. Presents the writer's explanation of the occurrence of gold in Cherry Creek, its tributaries, and other water-ways in Colorado. 2200 w. Min Rept—Dec. 22, 1898. No. 24991.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. Discussion of the paper by T. L. Carter. 4000 w. Jour of Chem & Met Soc of S. Africa—Nov., 1898. No. 25297 E.

Slimes.

Filter-Press Treatment of Gold Ore Slimes. William McNeill. Illustrates and describes this method of treatment and gives the opinion that in many cases it will prove more advantageous than other methods. 2500 w. Eng & Min Jour—Dec. 31, 1898. No. 24955.

IRON AND STEEL.

Blast Furnaces.

Note on Slips and Explosions in the Blast-Furnace. F. B. Richards. Illustrated description of an explosion occurring where the ores from the Lake Superior districts are used, given in the hope that suggestions of theory as to the cause may be elicited. 800 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24970 D.

Cast Iron.

Cast Iron in Railway Practice. G. R. Henderson. Reports experiments and analyses, with a study of the needs of certain classes of castings and the chemical constituents needed to meet the requirements. Ill. 1800 w. Am Eng & R R Jour—Jan., 1899. No. 24998 C.

Foundry Iron.

See Mechanical Engineering, Foundries.

French Iron Trade.

See Economics and Industry, Commerce and Trade.

Hot-Blast.

Hot Blast-Stoves for Pig-Iron Works. Joseph H. Harrison. Abstract of paper read at meeting of the Cleveland Inst. of Engs. On the merits of the Ford and Moncur hot-blast stoves. Also discussion. 3300 w. Col Guard—Dec. 23, 1898. No. 25057 A.

Iron Ore Trade.

See Economics and Industry, Commerce and Trade.

Iron Trade.

See Economics and Industry, Commerce and Trade.

Melting Iron.

See Mechanical Engineering, Foundries.

Steel Specifications.

Specifications on Structural Steel and Rails. Discussion by W. R. Webster, H. V. Wille, A. A. Stevenson, John Sterling Deans, Charles B. Dudley and Paul Kreuzpointner. 6000 w. Jour Fr Inst—Jan., 1899. No. 25125 D.

The Relations Between the Chemical Constitution and the Physical Character of Steel. William R. Webster. Investigation concerning the tensile strength of steel, quoting from various authorities and giving results of the writer's investigations. 12,000 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24975 D.

Steel Trade.

See Economics and Industry, Commerce and Trade.

Steel Works.

The Lorain Steel Company's Works, Ohio. Robert W. Hunt. An interesting illustrated account of the selecting of the site, the rapid building of substantial works, the arrangements for attractive homes for employes, &c., with detailed description of the plant. 4700 w. Engng—Jan. 6, 1899. Serial. 1st part. No. 25281 A.

The Works of the Illinois Steel Company, U. S. A. Describes the property and plants of the company, its business and resources in a general way, and particularly describes the largest plant, at Chicago. 4300 w. Engr, Lond—Dec. 23, 1898. Serial. 1st part. No. 25063 A.

Sulphide Ores.

The Treatment of Sulphide Ores. William Thomas. Read before the South Wales Inst. of Engs. Shows that all processes previously applied to these ores have proved disappointing and describes the treatment given at Tow Law, Weardale, Durham. 2400 w. Col Guard—Dec. 23, 1898. No. 25058 A.

MINING.

Alabama.

Alabama Mining in the Year 1898. A. H. Carpenter. A review of the progress of the coal and coke industry of the state. 1000 w. Mines & Min—Jan., 1899. No. 25123 C.

Automatic Doors.

Automatic Apparatus for Closing Levels in Mine Shafts.(Appareils Automatiques de Fermeture des Recettes dans le Puits de Mines.) H. Schmerber. Illustrated description of automatic doors operated by the passage of the cage, avoiding the danger of men or tram-cars falling down the shaft. 1500 w. Le Génie Civil—Dec. 24, 1898. No. 25414 D.

Boring.

The Raky Boring Apparatus. A. Lukaszewski, in *Oesterrichische Zeitschrift für Berg-und Hüttenwesen*. Illustrates and describes an improved percussion system which has worked well under trying conditions. 1200 w. Col Guard—Jan. 13, 1899. No. 25388 A.

California.

California as a Mining Country. Arthur Lakes. How it impresses a Coloradoan in regard to its general appearance and methods of working and treating the ores. 2300 w. Mines & Min—Jan., 1899. No. 25115 C.

Mining in California. J. R. Schuphaus A review of the general conditions surrounding the mining industry and its progress during 1898. 2200 w. Mines & Min—Jan., 1899. No. 25122 C.

Colorado.

Boulder Region, Colorado. Arthur Lakes. In regard to an examination made on a portion of it by an expert. 1600 w. Mines & Min—Jan., 1899. No. 25109 C.

Colorado Mining During 1898. Arthur Lakes. Some of the notable features of advancement and improvement made during the year. 1800 w. Mines & Min—Jan., 1899. No. 25119 C.

Electric Pumping.

Electric Mine-Pumping Plant. (Elektrische Betriebenen Wasserhaltung.) A description of a 750 h. p. underground electric pumping plant in the Maria Anna and Steinbach mines at Hontrop. 3500 w. Glückauf—Dec. 24, 1898. No. 25494 B.

Explosions.

Coal and Explosions. (Les Explosions dans les Mines de Houille et les Conséquences d'un Excés d'Aérage Artificiel.) Franz Büttgenbach. A short résumé of theories on this subject. 1500 w. Rev Univ des Mines—Dec., 1898. No. 24442 G.

Lake Superior.

Lake Superior Iron and Copper. Horace J. Stevens. The history of a prosperous year in the mining business of this district. 2000 w. Mines & Min—Jan., 1899. No. 25121 C.

Lewis River.

The Headwaters of the Lewis River. A. Thurston Heydon. A study of the country made by the writer while prospecting. 1200 w. Min & Sci Pr—Jan. 21, 1899. No. 25529.

Mine Drainage.

The "Copper Water" of Butte. George S. Binckley. The conditions existing at the Anaconda mines and the means of overcoming the corrosive action. 800 w. Min & Sci Pr—Jan. 21, 1899. No. 25528.

Mine Plant.

See Electrical Engineering, Power Application.

Mine Surveying.

Rocky Mt. Mine Surveying. Joseph Barrell. Some convenient methods especially suited to the conditions. Plumbing vertical shafts, surveying inclined shafts, methods for instruments commanding any vertical angle, also for those without extra attachments. Ill. 5000 w. Mines & Min—Jan., 1899. No. 24105 C.

The Evolution of Mine Surveying Instruments. Dunbar D. Scott. Historical review of the development of mine-surveying instruments, with numerous illustrations. 16,500 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24966 D.

Mistakes.

Mistakes in Mining. Edmund B. Kirby. Calling attention to mistakes and waste in mining and working of ores. 2000 w. Min & Sci Pr—Dec. 31, 1898. No. 25078.

Montana.

The Cottonwood Mine at Stockett, Montana. J. E. Stockett. Describes the mine and the haulage arrangements used. 1500 w. Mines & Min—Jan., 1899. No. 24116 C.

Pumping Machinery.

Mine Pumping Machinery. (Les Machines d'Epuisement Souterraines.) P. Habets. A general discussion of self contained mine pumps as distinguished from those mechanically driven from the surface. 5500 w. Rev Univ des Mines—Dec., 1898. No. 24443 G.

Tunneling.

Note on the Cost of Tunneling at the Melones Mine, Calaveras County, California. W. C. Ralston. Gives the cost of driving an adit at the Melones mine in 1898, and comparison with the cost of similar work at the Hogsback mine in 1888. 2000 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 23974 D.

Utah.

Mining in Utah. Don Maguire. Reviews the progress in the development of the various mineral properties of the state during 1898. 2500 w. Mines & Min—Jan., 1899. No. 25120 C.

Ventilation.

The Study of Mine Ventilation. On the importance and interest in this study and the need of a recent and able treatise on this subject. 3200 w. Col Guard—Jan. 13, 1899. No. 25386 A.

MISCELLANY.

Alloys.

Application of the Solution Theory to Metallic Alloys. (Beiträge zur Anwendung der Lösungstheorie auf Metalllegirungen.) Hanns von Jüptner. A discussion of the extension of the solution theory as developed by the author in connection with iron and steel, to other metallic alloys; with data from the experiments of Osmond, Le Chatelier and others. 3000 w. Stahl und Eisen—Jan. 1, 1899. No. 25493 D.

Metallic Alloys and the Theory of Solution. Charles T. Haycock. Abstract of a discourse delivered at the Royal Inst. Brief statement of results in investigating some of the properties of alloys in the liquid state. 1400 w. Nature—Dec. 29, 1898. No. 25147 A.

Aluminum.

The Present Position of Aluminum. The uses to which the metal has been put, especially those having regard to the requirements of the engineer. 1800 w. Prac Engr—Dec. 30, 1898. No. 25149 A.

The Properties of Aluminum. (Sur les Propriétés de l'Aluminum.) A. Ditte. A statement of the chemical properties of the metal, its resistance to attack by oxygen and acids. The conclusion is drawn that, before it is used for culinary or military utensils, the subject should

be more fully studied. 1500 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25406 G.

Annual Review.

Review of the Mineral and Metal Production for the year 1898. The usual important review of this publication, giving information of value and interest. 70,000 w. Eng & Min Jour—Jan. 7, 1899. No. 25140.

The Mineral Industry in 1898. Additional information concerning Alaska, Alabama, Arizona, Arkansas, California, Colorado, Kansas, Kentucky, Maryland, N. Carolina, S. Dakota, Vermont, Washington, W. Virginia, Wyoming, British Columbia and Utah. 21,500 w. Eng & Min Jour—Jan. 14, 1899. No. 25242.

Antifriction.

Study of White Alloys Called Antifriction. G. Charpy. Describes researches made to obtain a methodical classification to assist in deciding which alloy should be used in each individual case. Ill. 8500 w. Metallographist—Jan., 1899. No. 25255 E.

Antimony.

The Metallurgy of Antimony. A. Selwyn Brown. Gives a brief description of the early method of reduction, and the English process, now most largely used. Also outlines other methods used where conditions are favorable. 2300 w. Aust Min Stand—Nov. 24, 1898. No. 25041 B.

Arrastra.

How to Build and Operate an Arrastra. E. L. Ballou. Illustrated description. 3000 w. Min & Sci Pr—Jan. 14, 1899. No. 25365.

Brass.

Brass-Melting Furnaces. C. Vickers. Treats of their design, construction, and operation. Ill. 1400 w. Serial. 1st part. No. 25322.

Bronzes.

A Study of the Microstructure of Bronzes. A. E. Outerbridge, Jr. Investigations and conclusions are given, with photo-micrographs of specimens examined. Discussion. 5000 w. Jour Fr Inst—Jan., 1899. No. 25126 D.

Bye-Products.

The Recovery of Bye-Products. Editorial on the changed conditions which makes it doubtful whether the recovery of many of these waste products will pay. 1600 w. Engng—Jan. 6, 1898. No. 25285 A.

Cuba.

The Mineral Resources of Cuba. Jennings S. Cox, Jr. A well illustrated description of the mineral resources of the island, with special reference to their exploitation and their present development. The labor problem in Cuban mining is also discussed at some length. 3500 w. Engineering Magazine—Feb., 1899. No. 25436 B.

Hubnerite.

Hübnerite in Arizona. William P. Blake. Describes the occurrence in this new locality. Ill. 1000 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24971 D.

Kytchtym Medal.

The Kytchtym Medal. Dr. Persifor Frazer. This medal was one of the souvenirs given on the Ural excursion of the VIIth International Geological Congress. Describes the process of manufacture and the constitution of the metal. 600 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24973 D.

Life Saving.

Sanitary and Life Saving Appliances of the Shamrock Mine at Herne. (Sanitäts- und Rettungseinrichtungen auf der Zeche Shamrock bei Herne.) A very excellent account of the life saving appliances and system as used in the collieries of Westphalia; being an address before the society of mine superintendents at Herne, by G. A. Meyer. 5000 w. Glückauf—Jan. 1, 1899. No. 25496 B.

Manganese.

Manganese in Iron Ores and Pig Iron. R. R. Tatlock and R. T. Thomson. Read before the West of Scotland Iron and Steel Inst. Gives tabulated results of investigations of the different ores of commerce and the conclusions reached. 2000 w. Col Guard—Jan. 20, 1899. No. 25626 A.

Metallography.

The Progress of Metallography in 1898. Albert Sauveur. An outline of important recent contributions to the knowledge of metals and alloys. 2400 w. Metallographist—Jan., 1899. No. 25254 E.

Nickel.

Some Notes on the Recovery and Refining of Nickel. Sherard Cowper-Coles. Reviews briefly some methods for the treatment of nickel ore by electro-metallurgical methods. 1700 w. Elec Rev, Lond—Dec. 23, 1898. No. 25053 A.

Ores.

Treating Hard Low-Grade Ores. Walter J. May. Describes processes applicable to ores where disintegration, cleaning and separation are all that is necessary to render the ore fit for use or sale. 1800 w. Prac Eng—Dec. 23, 1898. No. 25051 A.

Plate Glass.

The Saint Gobain Plate Glass Manufactory. Illustrated description of the details of plate-glass making. 1800 w. Sci Am Sup—Jan. 14, 1899. No. 25195.

Quarries.

The Welsh Slate Quarries. Describes some of the important quarries and the systems of working. 2400 w. Eng & Min Jour—Dec. 31, 1898. No. 24954.

Tasmania.

The Minerals of Eastern Tasmania. H. Grout. Describes the formation and minerals of this district. 2700 w. Aust Min Stand—Dec. 8, 1898. Serial. 1st part. No. 25301 B.

Tin Mines.

The Tin-Mines of Bolivia. Charles S. Pasley. Paper read before the Inst. of Min. & Met., London. Describes the location and formation. 1400 w. Col Guard—Jan. 6, 1899. No. 25289 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene. Vivian B. Lewes. A series of 4 Cantor lectures. Gives the history of this gas, its analysis, properties, experiments, &c. 20,000 w. Jour Soc of Arts—Dec. 23 and 30, 1898, Jan. 6 and 13, 1899. Serial—4 parts. No. 25094 each A.

Cubic Feet of Acetylene to a Pound of Carbide. H. F. Fuller. An explanation of the theoretical combination and the calculations by which it is ascertained that the most acetylene that can be obtained from one pound of carbide is 5.584 cubic feet. 1400 w. Dom Engng—Jan., 1899. Serial. 1st part. No. 25500 C.

The Acetylene Standard of Light. H. E. Clifford and J. S. Smyser. A statement of results obtained in a recent investigation of some of the photometric properties of the acetylene gas flame, with an explanation of the apparatus used. Ill. 1500 w. Tech Quar—Dec, 1898. No. 25319 E.

Bunsen Burners.

The Lecomte System of Bunsen Burner Construction. On the work of M. A. Lecomte in this field. His low-pressure economical bunsen burner received recently a prize of 500 frs. 2000 w. Jour Gas Lgt—Dec. 27, 1898. No. 25090 A.

Equer's Apparatus.

Equer's Apparatus for Manufacturing Gas. A summary of the scope of this apparatus, with illustrations. 1500 w. Am Gas Lgt Jour—Jan. 23, 1899. No. 25502.

Etherion.

On the Supposed New Gas, Etherion. Sir William Crookes, in *Chemical News*. Results of experiments are given in support of the opinion that etherion is nothing more than aqueous vapor. 2500 w. Am Gas Lgt Jour—Jan. 2, 1899. No. 24992.

Gas Contamination.

The Contamination of Gas in Holders. M. Ymonet, in the *Journal de l'Eclairage au Gaz*. General observations on the causes of the contamination. 1200 w. Jour Gas Lgt—Jan. 10, 1899. No. 25333 A.

Gas-Holder Failure.

The Destruction of a Mammoth Gas Holder. An account of the collapse of the new gas-holder of the Consolidated Gas Co., in New York. Ill. 2400 w. Ir Age—Dec. 22, 1898. No. 24960.

The Gas Tank Failure in New York. Letters on this subject from Robert W. Prosser, George Rae, and W. H. Breithaupt. 2400 w. R R Gaz—Jan. 27, 1899. No. 25553.

Why the Gas Tank Failed. George Rae. Gives the opinion that the failure was due to faulty construction, or defects in design. 1600 w. Ill. R R Gaz—Jan. 6, 1899. No. 25074.

Gas Indicator.

The Lyncker and Schropp Gas Indicator. From *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrates and describes an apparatus for use in collieries, ships' bunkers, gas works, &c., based on the principle of the diffusion of gases. 900 w. Col Guard—Dec. 30, 1898. No. 25159 A.

Gas Supply.

Gas Supply. Editorial summary of the year 1898. 1200 w. Engr, Lond—Jan. 6, 1899. No. 25278 A.

Italian Conference.

The Conference of Italian Gas Managers. Notes on the visits paid to the gas works in Turin, and to the General Exhibition then being held in the city. 1800 w. Jour Gas Lgt—Dec. 27, 1898. No. 25089 A.

Mains.

Mains and Main-Laying. Comments on Mr. Forstall's paper read before the Am. Gas. Lgt. Assn. 1800 w. Jour Gas Lgt—Jan. 3, 1899. No. 25251 A.

Oxygen.

The Stuart Process for the Production of Oxygen. Romyn Hitchcock. Describes the development of this process and the application of oxygen to the manufacture of coal gas. Part first is an account of the various processes that have been tried for the economical production of oxygen on a large scale. 1800 w. Eng & Min Jour—Jan. 21, 1899. Serial. 1st part. No. 25364.

Pintsch Gas.

Pintsch Gas Plant, Manhattan Elevated Railroad, New York. Illustrated detailed description of the plant installed at 159th St., New York City, for supplying daily 1100 cars of the Manhattan Elevated Railroad. 2200 w. Am Eng & R R Jour—Jan., 1899. No. 24997 C.

Retrospect.

A Retrospect of the Year 1898. A review of the industry of gas-lighting in Great Britain, with some reference to artificial lighting by other means. 4500 w. Jour Gas Lgt—Dec. 27, 1898. No. 25086 A.

Returns.

The Gas Undertakings Returns. On the nature of the changes made and the principal totals as shown in the recently issued report for the United Kingdom. 1200 w. Jour Gas Lgt—Dec. 27, 1898. No. 25088 A.

Solubility.

The Solution of Solids and Liquids in Gases. M. P. Villard. Experiments showing that gas possesses sometimes considerable dissolving power. 1500 w. Am Gas Lgt Jour—Jan. 2, 1899. Serial. 1st part. No. 24993.

Water Gas.

Observations Upon Water-Gas. H. Bunte. Considers the Dellwick process, Strache's system, the danger of explosion, and the future non-luminous gas. 2400 w. Gas Wld—J 14, 1899. No. 25509 A.

The Theory of the Water-Gas Process. Abstract translation of a contribution by H. Luggin to the *Journal für Gasbeleuchtung*. Details theoretical considerations and experimental facts set forth by Hoitsema, and discusses the evils consequent of too low a temperature in the generator. 3000 w. Jour Gas Lgt—Dec. 20, 1898. No. 24994 A.

SEWERAGE.

Baltimore.

The Sewerage of Baltimore. Kenneth Allen. Read before the Am. Soc. of Munic. Imp. Describes the present situation and outlines the proposed system. 2200 w. Munic Engng—Jan., 1899. No. 25008 C.

Sewage.

Modern Processes of Municipal Sewage Treatment. (Die Behandlung Städtischer Spüljauche mit Besonderer Berücksichtigung Neuerer Verfahren.) A paper read before the German Sanitary Association by Dr. Dunbar, discussing the more recent chemical methods of treating sewage, with reference also to the bacterial and sedimentation processes. 4500 w. Gesundheits Ingenieur—Dec. 15, 1898. No. 25484 B.

Sewage Disposal.

A Novel Method of Sewage Disposal, Especially Designed for the City of Toronto. C. G. Horetzky. Details of the method adopted with cost of construction and annual maintenance. 2500 w. Can Engr—Jan., 1899. No. 25329.

Sewage Disposal. H. deB. Parsons. Gives a brief general description of properly designed disposal works, with information bearing on the subject of purification of water, &c. 2800 w. Stevens Ind—Jan., 1899. No. 25524 D.

Sewage Disposal by Bacteria Beds and the Septic Tank. Paper by George Thudichum on the conditions governing the use of these systems. 3300 w. Eng Rec—Dec. 31, 1898. No. 24987.

The Clinton, Mass., Sewage Disposal System. Illustrated description of a pumping plant, reservoirs, and filter beds built by the Metropolitan Water Board to prevent the pollution of the Nashua River. 1800 w. Eng Rec—Jan. 14, 1899. No. 25234.

STREETS AND PAVEMENTS.

Macadam.

Disputed Points in Connection with the Construction and Maintenance of Macadamized Roads. H. Irwin. A discussion on this subject by members of the Am. Soc. of Civ. Engs., gave diverse opinions, and the aim of the paper is to ascertain how far these opinions might be accounted for by difference in local conditions. 2300 w. Can Engr—Jan., 1899. Serial. 1st part. No. 25330.

WATER SUPPLY.

Berlin.

The Pumping Machinery for the Berlin Waterworks at Müggelsee. (Pumpmaschine für die Berliner Wasserwerke am Müggelsee.) Illustrated description of horizontal compound pumping engines, with plans, elevations, and photographic view of interior of engine room. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—Dec. 17, 1898. No. 25460 D.

Color of Water.

Methods for the Determination of Color and the Relation of the Color to the Character of the Water. Frederick S. Hollis. A study of the causes of increase and change of color, with methods of determination of the color. Also discussion. 7000 w. Jour N E Water Wks—Dec., 1898. No. 25293 F.

Control.

The Derwent and Ashop Water Supply Schemes. Leicester, Sheffield, and Derby are each contending for the entire control of the head waters of these rivers for the object of supplementing their supplies. The article describes the schemes as at present suggested, and the claims put forward by each town. Ill. 2500 w. Engr, Lond—Dec. 23, 1898. No. 25065 A.

Coolgardie Pipe Line.

The Contract for the Coolgardie Steel Pipe Line, Western Australia. Particulars regarding the contract and the pipe to be used for this line 328 miles long to be built by the government to supply water to the mining district. 1500 w. Eng News—Dec. 29, 1898. No. 24952.

Croton Dam.

The New Croton Dam. Illustrated description of the methods adopted in putting in the foundations. 1100 w. Eng Rec—Jan. 7, 1899. No. 25099.

Early Methods.

Early Methods of Collecting, Storing, and Distributing Water. W. R. Hill. Introductory remarks with description of the earliest construction work is given in part first. 2500 w. San Rec—Dec. 23, 1898. Serial. 1st part. No. 25129 A.

Electrolysis.

An Example of Electrolysis of Water Mains in Brooklyn, N. Y. Illustrates a specimen of the corroded pipe, and quotes from a report by an expert engineer. 1200 w. Eng News—Jan. 26, 1899. No. 25547.

Fire Service.

Description of the Separate High Pressure Fire-Service System of Providence, R. I. Edmund B. Weston. Gives plan showing pipe and hydrants, and illustrates the design of joints and the manner of securing curved pipe. 3000 w. Jour N E Water Wks—Dec., 1898. No. 25292 F.

Hydrant Rentals.

A Side Light on Hydrant Rentals. Review of a decision of the Supreme Court of Nebraska making all contract provisions in a water ordinance void unless clearly mentioned in the title. 800 w. Eng Rec—Jan. 14, 1899. No. 26233.

Jamaica.

The Normal Chlorine of the Water Supplies of Jamaica. Ellen H. Richards and Arthur T. Hopkins. Explains the topography of the island, and its position in the path of the trade

winds with the effects resulting; gives the method of collecting samples for analysis, and a table of analyses made, with remarks. 4400 w. Tech Quar—Dec., 1898. No. 25317 E.

Philadelphia.

The Water-Supply Problem of Philadelphia. Reviews a report by J. W. Ledoux on schemes for improving the supply and his estimates of the cost of filtering. 1800 w. Eng Rec—Jan. 7, 1899. No. 25098.

Pollution.

The Prevention of Pollution of Streams and Rivers. Part of a paper read by Dr. Childs at the recent Sanitary Congress at Birmingham, Eng. On the defects in the Rivers' Pollution Act, and needed amendments; the methods employed by the joint committees, and results attained. 3800 w. Builder—Dec. 31, 1898. No. 25164 A.

Pumping.

Possibilities of Economy in Pumping Engines. George H. Barrus. Condensed abstract of paper read at meeting of the New England Water-Works Assn. Reviews a comparative examination of five tests of triple-expansion pumps. 800 w. Eng Rec—Jan. 28, 1899. No. 25589.

See Mechanical Engineering, Steam Engineering.

Pure Water.

Principles Involved in the Selection of Water Supply. (Grundsätze bei der Beurteilung von Trink- und Nutzwasser.) Report of a committee of the Society of German Chemists, giving the questions which should be answered in critically examining any proposed source of water supply. 3500 w. Gesundheits Ingenieur—Dec. 31, 1898. No. 25487 B.

Review.

Water and Sanitary Affairs. A review of the principal events of the year 1898 in England. 3700 w. Jour Gas Lgt.—Dec. 27, 1898. No. 25087 A.

Surface Water.

Surface Water Supplies of Massachusetts. John C. Haskell. Some of the reasons why surface water supplies are not desirable, with report of the waters of the state named. 2000 w. Jour N E Water Wks—Dec., 1898. No. 25291 F.

Vienna.

The Pumping Machinery of the Breitensee Waterworks. (Die Maschinenanlage des Wasserwerkes von Breitensee.) C. Budil. A very fully illustrated account of this important station of the Vienna water supply system, showing especially the application of the Riedler system of mechanically operated water valves. 3500 w. 2 plates. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 25468 D.

Water Filter.

An Improved Filter for Microscopical Water Analysis. Daniel D. Jackson. Illustrates and describes an invention of the writer the use of which has given very satisfactory results. 1500 w. Tech Quar—Dec., 1898. No. 25318 E.

Water Mains.

A Symposium on Pipe Lines. Reviews the papers on large cast-iron and riveted steel mains, and the salt-water fire-protection system of Boston, presented to the N. E. W. W. Assn. 1700 w. Eng Rec—Jan. 14, 1899. No. 25241.

Water Meters.

The Accuracy and Durability of Water Meters. John W. Hill. Report of examination by the writer of seventeen different meters, with discussion of tests by others, the construction features of meters, their durability, etc. Ill. 6500 w. Pro of Am Soc of Civ Engs—Jan., 1899. No. 24572 F.

Water Purification.

Application of the Anderson Process to the Water of the River Plate. (Aplicación del Procedimento Anderson á las Aguas del Río de la Plata.) Carlos Doynel. A comparison between sand filtration and the Anderson process, giving data of analyses and experiments made by a sanitary commission at Buenos Aires. 3000 w. La Ingeniera—Nov., 1898. No. 25407 E.

The Preparation of Water for Industrial Purposes, and the Purification of Discharge Water. (Die Aufbereitung der Fabrikationswässer vor dem Gebrauch und die Reinigung von Abwässern.) B. Schnackenburg. Giving methods of purification by filtration, neutralization, precipitation, &c., both before and after use. 2500 w. Gesundheits Ingenieur—Dec. 31, 1898. No. 25486 B.

Water Rates.

The New Water Rates in Milwaukee. Discussion of the first attempt to introduce a uniform rate for water, whether supplied in large or small quantities, or charged by meter or fixture schedules. 1200 w. Eng Rec—Dec. 31, 1898. No. 24982.

Watersheds.

The Desirability of Making Watershed Areas and Sanitary Districts Coterminous. R. E. Middleton. Reprinted from the *Journal of the Sanitary Inst.*, England. An able discussion of the subject. 7500 w. Jour N E Water Wks—Dec., 1898. No. 25294 F.

Water Supply.

Water Supply. Editorial yearly review of the events in the United Kingdom. 2200 w. Engr, Lond—Jan. 6, 1899. No. 25277 A.

Water Supply from the Lower Greensand at Leighton Buzzard. H. Bertram Nichols. Read at meeting of the British Assn. of Water-Works Engs. A statement of the conditions of the supply of the named town, with analysis of the water. Discussion. 6800 w. Jour Gas Lgt—Dec. 20, 1898. No. 24995 A.

Water Works.

Simla Water-Works. C. E. V. Goument. Illustrates and describes the new works. 2700 w. Ind & East Eng—Dec., 1898. No. 25368 D.

The New Duluth Water-Works. Illustrated description of the riveted steel in take with flexible and hook joints, pumping station, force main, frost boxes on bridges, and other features. 2800 w. Eng Rec—Jan. 21, 1899. No. 25352.

The U. S. Supreme Court on the Rights of a Private Water Company. A review of an important decision restraining a city from building works after granting a franchise to a company. 2500 w. Eng Rec—Jan. 28, 1899. No. 25581.

The Water-Works of Plymouth, England, Illustrates and describes two dams of unusual construction. 2000 w. Eng Rec—Jan. 28, 1899. No. 25584.

MISCELLANY.

Garbage.

Garbage Disposal. Arthur R. Reynolds. R Reynolds. Read before the Am. Soc. of Munic. Engs. A study concerning the wastes of Chicago, but having general application. Considers collection and disposal. 1600 w. Munic Engng—Jan., 1899. No. 25009 C.

Havana.

The Importance of Cleaning Havana. Editorial statement of the results in the past of its unsanitary condition. 1600 w. Eng Rec—Jan. 21, 1899. No. 25348.

The Sanitation and Public Works of Havana. Extracts from General Greene's review and from G. E. Hill's presentation of Col. Waring's views, with comments. 2200 w. Eng News—Jan. 12 1899. No. 15188,

The Sanitation of Havana. Extracts from the report of General Francis V. Greene giving ioformation on the unsanitary condition of the Cuban capital. 2400 w. Eng Rec—Jan. 7, 1899. No. 25100.

Municipal Engineers.

The Duties and Compensations of Municipal Engineers. A. D. Thompson. Enumerates the most important duties required, and gives statistics relating to salaries paid, with comments. 1300 w. Munic Engng—Jan., 1899. No. 25006 C.

Municipal Work.

A Review of Important Municipal Work in America. George H. Benzenburg. Read at Washington meeting of the Am. Soc. of Munic. Imp. Compiled from replies to a circular letter of inquiry. 4800 w. Munic Engng—Jan., 1899. No. 25007 C.

Sanitary Engineering.

Sanitary Engineering. The annual editorial survey deals principally with the question of the treatment of sewage. 1800 w. Engr, Lond—Jan., 1899. No. 25276 A.

See Civil Engineering, Miscellany.

Snow.

Experiments and Notes on the Removal of Snow. (Experimentelles and Kritisches über Schneebeseitigung.) Dr. Th. Weyl. A discussion of the various methods of disposal of snow in continental cities; also of the impurities contained in snow. 2500 w. Gesundheits Ingenieur—Dec. 15, 1898. No. 25483 B.

Fighting Snow. Illustrates and describes plans used on roads in various cities of the west. 1000 w. St Ry Rev—Jan. 15, 1899. No. 25370 C.

Subways.

City Subways for Pipes and Wires. Henry F. Bryant. A discussion of present practice and its inconvenience and disadvantages, with an account of the Paris sewers, and suggestions for an improved system in American cities. Ill. 3400 w. Cosmopolitan—Feb., 1899. No. 25376.

West Indies.

Sanitary Conditions of Some West Indian Cities. F. C. S. Part first describes the conditions at Port au Prince, Hayti. 1800 w. San Plumb—Jan., 1, 1899. No. 25136.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

The Lehigh Valley Head Collision at West Dunellen, N. J. Brief illustrated account. 300 w. Eng News—Jan. 19, 1899. No. 25347.

Train Accidents in the United States in November. Detailed list and classified summary. 4800 w. R R Gaz—Jan. 13, 1899. No. 25215.

Central London Ry.

Some Notes of the Central London Railway. Gilbert Rosenbusch. Illustrates the tunnel work and gives interesting information. 1000 w. Eng News—Dec. 29, 1898. No. 24945.

European Travel.

How People Travel in Europe. Angus Sinclair. Briefly traces the progress of locomotion, describes the compartment car and comments on its drawbacks. Discussion follows. 11,000 w. N Y R R Club—Dec. 15, 1898. No. 25208.

Prussia.

The Prussian Railways in the Year 1848. (Die Prussischen Eisenbahnen im Jahre 1848.) A general description of the Prussian railway system fifty years ago, with map, and an account of the methods of operation and administration. 5000 w. Glaser's Annalen—Jan. 1, 1899. No. 25480 D.

Train Rules.

The New Standard Code. Editorial on the revised code of the Chesapeake & Ohio. 1800 w. R R Gaz—Jan. 20, 1899. No. 25336.

FINANCIAL.

New York Railroads.

The Railroad Situation in the State of New York. Editorial review of the sixteenth annual report of the board of railroad commissioners of the State of New York. 1400 w. Ry & Engng Rev—Jan. 7, 1899. No. 25180.

LEGAL.

Interstate Commerce.

Judge Knapp on the Present Status of the Law. Gives views of Hon. Martin A. Knapp as given in a lecture and informal talk at the Univ. of Pennsylvania. 1000 w. R R Gaz—Dec. 30, 1898. No. 24957.

The Interstate Commerce Commission. Abstract of report, taken from advance sheets, touching pooling, free storage, railroad earnings, safety appliances, and accidents. 2000 w. Ir Age—Jan. 19, 1899. No. 25323.

The Powers of the Interstate Commerce Commission. Milton H. Smith. A reply to the article of Charles A. Prouty, in the Nov. number of this publication. 5500 w. N Am Rev—Jan., 1899. No. 24978 D.

Kansas.

New Railroad Law in Kansas. Gives the principal provisions of the new bill. 1800 w. Ry Age—Jan. 13, 1899. No. 25263.

Receiverships.

The Movement in Receiverships during 1898. Editorial presenting facts showing that the railroads have practically recovered from the panic of 1893, and that it is probable that the railroad mileage in the hands of receivers will soon be as low as it ever has been in the history of the United States. 1500 w. R R Gaz—Jan. 6, 1899. No. 25077.

MOTIVE POWER AND EQUIPMENT.

Air Brake.

The Standard Air Brake as Applied to Tramways and Light Railway Cars. Illustrated detailed description, with statement of advantages claimed. 1500 w. Ry Wld—Jan. 5, 1899. No. 25505 A.

Body Bolsters.

Recent Freight Car Body Bolsters of the Chicago, Rock Island & Pacific. Illustrates designs in malleable iron and cast steel which provide ample strength for cars of 60,000 and 80,000 lbs. capacity, and have many features of interest. 1000 w. R R Gaz—Jan. 27, 1899. No. 25554.

Couplers.

The Saving of Lives and Limbs by Automatic Car Couplers. Editorial on recent statistics from the Interstate Commerce Commission's report, showing a marked reduction in the casualties among railway employees. 900 w. Eng News—Jan. 19, 1899. No. 25346.

Fast Runs.

Fast Runs on The Northern Railway of France. Charles Rous-Marten. Describes, with illustrations of the engines, a number of service runs of high-speed expresses of the Chemin de Fer du Nord, and gives numerous interesting and valuable data of locomotive performance. 6000 w. Engineering Magazine—Feb., 1899. No. 25439 B.

Freight Cars.

Steel Freight Cars of 100,000 lbs. Capacity, Pittsburg, Bessemer & Lake Erie R. R. Illustrates and describes one of the latest styles of steel cars. 1000 w. Eng News—Jan. 19, 1899. No. 25345.

Fuel Saving.

Fuel Saving on the Wabash. An account of the methods adopted which have resulted in great saving. 1500 w. R R Gaz—Jan. 20, 1899. No. 25335.

Locomotive Performance.

The Performance of the Vauclain Compound Locomotive. Extract from discussion by S. M. Vauclain, at the meeting of the St. Louis Ry. Club, showing that the results obtained by R. A. Smart, in the laboratory of Purdue Univ. were actually what takes place in service with this type of locomotive. 2300 w. R R Gaz—Dec. 30, 1898. No. 24956.

Locomotives.

A Heavy Consolidation for the Lehigh Valley. Dimensions and engravings showing the appearance of the engine, and the details of the boiler. 200 w. R R Gaz—Jan. 13, 1899. No. 25213.

A Locomotive with Oscillating Cylinders. Illustrates and describes a curious logging locomotive. 700 w. Sci Am—Dec. 31, 1898. No. 24940.

An Old Reading Engine. C. H. Caruthers. An account of an engine built in 1844 which exploded its boiler just 19 days after being put into service. The cause, as determined by investigations, is given. Ill. 1000 w. R R Gaz—Jan. 6, 1899. No. 25075.

French High Speed Compound Locomotives. From *La Nature*. Illustrates the locomotives of recent type, used on the Railway of the North, and gives the results realized in their operation. 1200 w. Sci Am Sup—Jan. 21, 1899. No 25343.

Locomotives for Japan. Descriptive specification, with engraving, of engines built in Schenectady. 400 w. R R Gaz—Jan. 27, 1899. No. 25557.

Passenger and Goods Locomotives for the Inter-Oceanic Railway, Mexico. Illustrated detailed descriptions of two powerful engines. 1000 w. Engng—Jan. 13, 1899. No. 25382 A.

Power and Speed of Locomotives. G. R. Henderson. Discussion of this subject, with diagrams. 600 w. R R Gaz—Jan. 27, 1899. No. 25559.

Rapid Mounting of a Locomotive. From *La Nature*. Describes the mounting of a high-speed freight engine in 66 hours in the shops of Epernay. Ill. 600 w. Sci Am Sup—Dec. 31, 1898. No. 24943.

The Relation Between Power and Speed of Locomotives. Editorial on recent views presented by Prof. Smart and Mr. Vauclain. 800 w. R R Gaz—Jan. 13, 1899. No. 25216.

Private Car.

Private Railway Car. Illustrated detailed description of the fine car built for H. M. Flagler. 500 w. Engr, Lond—Jan. 13, 1899. No. 25392 A.

Tests.

Tests of Materials and Their Purchase under Specifications. Alfred Lovell. Extracts from a paper read at meeting of the Northwest Ry. Club. Stating the advantages to buyer and seller, the economy, and desirability of buying under specification. 2500 w. Ry & Engng Rev—Dec. 31, 1898. No. 25005.

Train Control.

Prof. Elihu Thomson's System of Electric

Train Control. Illustrated description. 900 w. Elec Eng, N. Y.—Jan. 19, 1899. No. 25340.

Train Lighting.

The Electric Lighting of Trains. Robert A. Ross. Considers the several systems and their cost; their advantages and disadvantages, and the need of suiting the system to the conditions. 1800 w. Can Engr—Jan., 1899. No. 25328.

Train Resistance.

Train Resistance. A series of diagrams selected from a record from minute to minute of the work done by an engine in hauling a train on the Caledonian Ry. Also a chart of combined results. Editorial discussion of the diagrams and what they prove. 1800 w. Engr, Lond—Dec. 23, 1898. No. 25066 A.

NEW PROJECTS.

Arctic Railroad.

An Arctic Railroad. Information concerning a road to be built across northern Norway and Sweden, to furnish an outlet for the iron mines. 1300 w. Sci Am—Dec. 31, 1898. No. 24939.

Ecuador.

Railway in Ecuador. Report relative to the Guayaquil and Quito Railway. 2000 w. U. S. Cons Repts, No. 314—Jan. 3, 1899. No. 24965 D.

Indo-China.

The Railways of Indo China. (Les Chemins de Fer de L'Indo-China.) Henry Haguet. Description, with a map, of the proposed system of railways now under discussion in the French Chamber of Deputies. 1100 w. Jour des Transports—Dec. 3, 1898. No. 25424 B.

Japan.

A Progressive Japanese Railroad. Willard C. Tyler. Some interesting particulars in regard to the Sanyo Railway. 2000 w. Ry & Engng Rev—Jan. 21, 1899. No. 25372.

Trans-Caspian Railroad.

The Building of the Trans-Caspian Railroad. Notes from a paper by General Annenkoff, published in the Nov. Bul. of the International Railway Congress, concerning the methods pursued in the construction of the line. 1200 w. R R Gaz—Jan. 27, 1899. No. 25556.

PERMANENT WAY AND FIXTURES.

Block System.

Automatic Block Signals for Railways. (Verschluss der Fahrstrassen durch Stellwerke.) A paper read before the German Railway Society by Herr Leschinsky describing a variety of automatic electric block systems operated by the passing trains. 6000 w. Glaser's Annalen—Jan. 1, 1899. No. 25481 D.

Boston Terminal.

Opening of the Boston Terminal. An account of the opening of the new South Union Station, with description of the building, its equipment and general arrangement. 3300 w. R R Gaz—Jan. 6, 1899. No. 25073.

The New Boston Terminal Station. Elevation and illustrations with description of the new south station of the Boston Terminal Company. 2300 w. Ry Age—Jan. 6, 1899. No. 25142.

The New Southern Terminal Station, Boston. Illustrated description of the new depot of the Boston & Albany, and New York, New Haven & Hartford systems, which has accommodations for 2000 trains in 18 hours. Part I describes the station as a whole and the details of the foundations. 3000 w. Eng Rec—Dec. 31, 1898. Serial. 1st part. No. 24983.

China.

The Shanghai-Wusung Railway. (Die Shanghai-Wusung Bahn.) A brief account of this reeently completed railway in China, with details of cost and views of the terminal stations. 1200 w. Zeitschr Oesterr Ing u Arch Ver—Dec. 30, 1898. No. 25477 B.

English Signaling.

Criticism of English Railroad Signaling. Charles Hansel. Cites cases of collisions and discusses the causes. 2200 w. R R Gaz—Dec. 30, 1898. No. 24958.

Gauge Widening.

On the Measurement of Super-Elevation and of the Widening of Gauge. A. Bewley. Considers devices used in this work and the simplest means of measuring for the adjustment of tracks. 1000 w. Ind Engng—Dec. 10, 1898. No. 25306 D.

Grain Warehouse.

A Grain Storage Warehouse Plant for Berlin. (Getreide-Silo-Anlage für Berlin.) M. Buhle. The prize essay of the German Society of Mechanical Engineers for 1896-1897, presenting a complete grain storage and handling scheme for the goods railway station at Berlin. Serial. Part I. 4000 w. 1 plate. Glaser's Annalen—Jan. 1, 1899. No. 25482 D.

Interlocking.

New Interlocking Plant at 101st Street, Chicago. Illustrated description. 1000 w. Ry & Engng Rev—Jan. 14, 1899. No. 25266.

Manning Rail.

The Manning Improved Rail. W. T. Manning. Description with diagrams, and the advantages claimed. Also editorial discussion. 3300 w. R R Gaz—Jan. 27, 1899. No. 25558.

Orleans Terminal.

Electric Traction on the Orléans Railway Extension. (La Traction Electrique sur le Prolongement de la Ligne d'Orléans dans Paris.) Short description of method of electric traction to be used in this tunnel line on account of difficulties of ventilation. 1800 w. Le Génie Civil—Dec. 17, 1898. No. 25411 D.

Extension of the Orléans Railway Line in Paris. (Prolongement de la Ligne d'Orléans de la Place Valhubert au Quai d'Orsay.) A. Boudon. An illustrated description of the present condition of the work. Serial. 1st part. 1500 w. Le Génie Civil—Jan. 7, 1899. No. 25416 D.

Permanent Track.

A Design for a Permanent Track for Steam Railways. J. W. Schaub. Illustrates and describes a design for a permanent roadbed and track. Also a lengthy editorial examining the above design and describing a construction de-

veloped by a member of the editorial staff. 7000 w. Eng News—Jan. 5, 1899. No. 25028.

Rail Joints.

The Weakest Point in Rail Joints. John King. Explains the writer's ideas of rail joints and fastenings. He considers the strength of the two inner bolts in the splice bar and the nearness of these bolts to the rail ends are the most important points. 700 w. R R Gaz—Jan. 20, 1899. No. 25334.

Rails.

On the Advantage of Using Heavier Rails for Railways Laid with Flange Rails. C. P. Sandberg. On the changed conditions which make it advisable to use more steel, thus securing cheaper roads, cheaper freights, and safety for higher speeds on British railways. 2000 w. Engng—Jan. 13, 1899. No. 25385 A.

Round-House.

New Round-House, 27th Street, Chicago, Illinois Central Ry. Plan of yards, boiler room and shops, with description. 900 w. Ry & Engng Rev—Dec. 31, 1898. No. 25004.

Signals.

Electric Signal Apparatus at Atlantic City, N. J. Illustrated description of the principal features of the electric signaling system recently installed by the weather bureau. 1000 w. W Elect'n—Jan. 14, 1899. No. 25253.

Sound Signalling at Sea. Investigations recently made by Emile Lacoine. A statement of problems and varying conditions and his means of obtaining distances. 3800 w. Engng—Jan. 6, 1899. Serial. 1st part. No. 25280 A.

Rail Circuit Signals on the Boston and Albany. George W. Blodgett. A discussion of the operation of signals under the control of a rail circuit, the construction work, batteries, &c., with report of the changes to the rail circuit on the B. & A. Ry. 2400 w. R R Gaz—Jan. 6, 1899. No. 25072.

Stations.

Pittsburg & Lake Erie R. R. Passenger Station at Beaver, Pa. Karl J. C. Zinck. Illustration, floor plan, and general plan of grounds, with description of an attractive station. 400 w. Eng News—Jan. 12, 1899. No. 25189.

The Design of Railway Stations. This first article of a series deals largely with the arrangements of stations, with some comment on architectural design. 3500 w. Eng News—Jan. 12, 1899. Serial. 1st part. No. 25187.

Tunnel Repairing.

Repairing a Tunnel on the Western and Atlantic R. R. W. H. Whorley. Read before the Engng. Assn. of the South. Describes this work on a tunnel passing through a ridge in the Chattanooga Mts. It was carried on without interrupting traffic. 1600 w. Eng News—Jan. 26, 1899, No. 25548.

TRAFFIC.

Car Carding.

The Canadian Pacific Car Carding System. A description of a system that has proved efficient. 1600 w. Ry Age—Jan. 20, 1899. No. 25374.

Railway Engineering.

Railway Engineering, and Its Relation to Traffic and Economic Conditicns. E. E. Russell Tratman. A discussion of this branch, showing the important relations which it bears to railway operation and the railway system in general. 5400 w. Wisconsin Engr—Jan., 1899. No. 25203 D.

Rates.

Decline in Railway Rates and Profits. John Moody. Claims that while the actual return on capital has materially decreased, the actual return on money has not fallen off in the same ratio. Discusses the wealth-cheapening tendency and its cause. 1800 w. Gunton's Mag—Jan., 1899. No. 25071 C.

Stable Rates. Editorial discussion of freight rates and the agreements of the presidents of the trunk lines. 1600 w. R R Gaz—Jan. 27, 1899. No. 25560.

The B. & O. Receivers on Rate Cutting. Copy of a letter sent to the Interstate Commerce Commission last week, with editorial comment. 1300 w. Ry & Engng Rev—Dec. 31, 1898. No. 25003.

The Outlook for Railroad Rates. Brief discussion of points affected by the agreement made between the presidents of the principal lines and the Interstate Commerce Commission. 700 w. Bradstreet's—Jan. 28, 1899. No. 25590.

Tonnage.

Train Tonnage for Locomotives. Relating to the system recently put into effect on the Ontario & Quebec Div. of the Canadian Pacific Railway. 600 w. Ry Age—Jan. 13, 1899. No. 25262.

Traffic.

Events of the Year in the Traffic Field. Editorial review of the events and experiences during 1898. 2000 w. R R Gaz—Dec. 30, 1898. No. 24959.

STREET AND ELECTRIC TRAMWAYS.

Accounts.

An Ideal System of Street Railway Accounts. A. O. Kittredge. Gives a chart of analysis and classification, with description of a system proved successful in many enterprises. 3000 w. St Ry Jour—Jan., 1899. No. 25035 D.

Trip and Mileage Accounts on the Lynn & Boston. F. E. Smith. Explains the details of the system used in keeping an account of the trips run from which the mileage is computed. 1300 w. St Ry Rev—Jan. 15, 1899. No. 25369 C.

Conduit and Trolley.

Trolley and Conduit Tramway in Paris. (Tramway Electrique à Trolley et à Caniveau de la Place de la Bastille à Charenton.) G. Boeto. A well illustrated and complete description of this new line. The conduit construction is similar to that recently installed in New York.

5000 w. 1 large plate. Le Génie Civil—Dec. 31, 1898. No. 25415 D.

Contact System.

Campbell Surface Contact System of Electric Traction. Illustrates and describes this system and states its advantages. 1100 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25174.

Cork, Ireland.

Cork Electric Tramways and Electric Works. Full description of the electrical works of the Cork Electric Tramway and Lighting Co., Ltd., with illustrations and map. 3500 w. Elec Eng, Lond—Dec. 23, 1898. No. 25047 A.

Electric Tramway System of Cork, Ireland. Gives map of tramways with brief description. 2200 w. St Ry Jour—Jan., 1899. No. 25036 D.

Dublin.

See Electrical Engineering, Generating Stations.

Electrical Survey.

An Electrical Survey of the Borough of Manhattan, New York City. Discussion of A. A. Kundson's paper on this topic. 2400 w. Trans of Am Inst of Elec Engs—Nov., 1898. No. 25521 D.

Electric Traction.

Electricity for Operating Trains on Italian Railways. (L'Energia Elettrica Applicata ai Treni delle Ferrovie Italiane.) A study of the possibilities of utilizing the numerous Italian water-powers for the operation of the present steam railway system, containing some interesting data. 2400 w. Annali d Soc d Ing e d Archit Ital—Sept., Oct., 1898. No. 24871 E.

Generating Stations.

See Electrical Engineering.

Germany.

Statistics of the Electric Tramways of Germany. (Die Statistik der Elektrischen Bahnen in Deutschland.) The annual review of electric tramways with a fully tabulated statement of the development during 1897-1898. 12,000 w. Elektrotech Zeitschr—Jan. 5, 1899. No. 25445 B.

Light Cars.

Light Passenger Cars—The Manhattan Elevated Railroad. Illustrates the framing of the cars which have been in use on the Manhattan Elevated Railroad in New York, and given satfactory service. 800 w. R R Car Jour--Jan., 1899. No. 25231.

Lyons, France.

Electric Traction at Lyons, France. Brief account of the recent change of all lines to electric traction, describing the system adopted. 1500 w. Elec Wld—Dec. 31, 1898. No. 24923.

Electric Traction at Lyons. (La Traction Electrique à Lyon.) Description, with maps and illustrations of the 12 lines of the Compagnie des Omnibus et Tramways at Lyons. Both trolley and conduit systems are in use. 3000 w. L'Electricien—Nov. 19, 1898. No. 24867 B.

Porto Rico.

The Exploitation of Electric Tramways in Porto Rico. Antonio Mattei Lluveras. This well illustrated article describes the needs of Porto Rico for some system of transportation better than mule back. It contains much valuable information concerning the resources of the island. 4200 w. Engineering Magazine—Feb., 1899. No. 25440 B.

Rapid Transit.

A Feasible Plan for the New York Rapid Transit Ry. Editorial, discussing some of the engineering features of the enterprise, and outlining a plan based on securing an arrangrment with the Metropolitan St. Ry. Co. for the operation of a system of express tunnels beneath some of the North and South lines. 2200 w. Eng News—Dec. 29, 1898. No. 24947.

Storage Station.

See Electrical Engineering, Generating Stations.

Street Railway Changes.

Equipment of the Broadway Cable Line with Electricity. Illustrates and describes the work being carried on by the Metropolitan Street Railway Co. 1000 w. Sci Am—Dec. 24, 1898. No. 24701.

Three-Phase Railway.

The Three-Phase Electric Railway from Stausstadt to Engelberg. Charles Rochat. Illustrates and describes this road, its electric equipment, rolling stock, and operation. 3800 w. St Ry Jour—Jan., 1899. No. 25033 D.

Track.

Some Examples of Tracklaying for Street Railways. (Einige Aufgaben über Berechnung von Gleisanlagen für Strassenbahnen.) Especially devoted to methods of laying out curves and turnouts, given problems being solved in detail. 2500 w. Ill. Zeitschr f Klein u Strassenbahnwesen—Dec. 1, 1898. No. 24829 D.

Tramways.

A Combined Overhead and Conduit System in Paris. Illustrated detailed description. Great care was given to the overhead work, with most pleasing results. The line has many innovations in its constructional features. 2200 w. Ry Wld—Jan. 5, 1899. No. 25504 A.

Barcelona Electric Tramways. An illustrated detailed description of the tramways of the largest city in Spain. 4000 w. Ry Wld—Jan. 5, 1899. No. 25503 A.

Tramway Schemes for 1899. A report of English, Scotch and Irish schemes for the coming year. 2200 w. Transport—Dec. 30, 1898. No. 25134 A.

Underground Railroads.

For Paris Underground Railroads. From the *Moniteur Industriel*. An account of the plan to construct 33½ miles of underground electric roads. 1500 w. R R Gaz—Nov. 25, 1898. No. 24207.

Paris Metropolitan Underground Electric Road. Some particulars relating to this road now in process of construction. Ill. 600 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25533.

Book Reviews.

Commercial Cuba. A Book for Business Men, by William J. Clark, with an introduction by E. Sherman Gould. Illustrated. New York: Charles Scribner's Sons. 1898

This work may fairly be called the most important collection of data regarding Cuba that has been published. Perhaps its most noticeable feature is the directness with which the author has gone to work to justify his title,—to write a business book for business men. In the majority of cases books of this character, those purporting to give facts of value, err either by misstatements of the conditions with which they deal, or by the inclusion of matter without interest to the exclusion of matter of really vital importance. The handsome volume that Mr. Clark has compiled, largely from the results of his personal travel and observation in the island, is without doubt trustworthy, and equally full of matters that are of real interest to one wishing either to go to Cuba, or to enter into any business relation with Cuban people. It is essentially a book for business men.

It should not be thought that this fact robs the work of any interest to others than those contemplating entering business relations with the island. On the contrary the author has succeeded in maintaining an admirable style throughout, and in presenting his facts in a very attractive guise. The fine illustrations accompanying the text are well chosen to show the peculiarities of Cuban scenery and manners, while the numerous maps and plans of cities will be found of great value.

The necessary work of demolition having been accomplished in the island, and the conditions which have so long restrained its progress having been removed, the vastly more important work of reconstruction is about to begin. To the English-speaking people who will have this work in hand such books as this volume of Mr. Clark's will be of the highest value. He has recognised the importance of understanding the social and personal peculiarities of the Cubans, and his chapters on these points are not only interesting but valuable. The chapter on the climate of the island and the rules to be observed for the preservation of health by unacclimated foreigners is one that will be of great use to a stranger visiting the island. Without being in any sense either a guide-book or a mere compilation of statistics, the work succeeds in being both a collection of data and a manual for travelers; but perhaps the best praise that can be given it is that it lives up to its title,—a book for business men. It is emphatically that, and, as such, a work of real importance and permanent value.

Manufacturers' Export Code, by Charles L. Seeger. New York: United States Industrial Publishing Co. 1898.

This telegraphic code presents several novel and distinctive features which recommend it to English-speaking manufacturers seeking trade in Spanish-speaking countries. The book can be used with equal facility by both English- and Spanish-speaking persons, the code words appearing in the centre of the page with the translation on either side in these two languages. A strictly alphabetical arrangement of phrases by principal words is, therefore, impossible; but, on the other hand, the arrangement and classification of the different subjects render them quite accessible for quick and effective use, while a very complete alphabetical index in both English and Spanish serves to direct the new user of the code to desired subjects. The code is designed primarily for the use of those making or dealing in American manufactures and products and raw materials, and for this reason many phrases found in general alphabetical codes are omitted, while in compensation therefor it has been possible to go into fuller details regarding the goods themselves, and the many different

ways of ordering, shipping, specifying particular kinds of goods, payments, etc. The arrangement of the code is very ingenious, and one's appreciation of it grows with familiarity. The verb has been taken as the keyword for any general phrase, and, by a tabular arrangement, twenty-four different combinations of each of some 300 verbs, or about 7,000 different phrases in each language, are given in the space of only twenty-three pages. Manufactures and products are treated in a similar manner, with the result that a single word message can be made to ask discounts on almost anything, or order it, while two or more words can be made to ask any one of several questions, give shipping directions, specify mode of payment, or manufacturer and brand if the order is given through a commission merchant. About 100,000 messages in both Spanish and English are contained in the code, covering all ordinary business transactions. The ciphers used are taken from the vocabulary compiled by the International Telegraph Bureau, at Berne, and are consequently transmissible by all cables of the world.

LIGHTING BY ACETYLENE, Generators, Burners, and Electric Furnaces. By William E. Gibbs, M.E. Second Edition. New York: D. Van Nostrand Co. London: Crosby, Lockwood and Son. 1899.

The first edition of Mr. Gibbs's book appeared early in 1898 and was a welcome contribution to the literature of a subject about which but little authoritative information had been given.

That it was needed is shown by the fact that a second edition has been demanded, and in this revision the progress which has been made during the interval has been thoroughly covered, and the work brought up to date.

The book is an excelled companion to the well-known French treatise of Pellissier, but, as the latter has not as yet been translated, the new work is welcome as giving to English readers a record of the most important advances which have been made in lighting by acetylene. Mr. Gibbs rightly considers the best form of generator that in which the carbide is entirely submerged in a comparatively large bulk of water, and a number of generators on this and other plans are described and illustrated. The author's experiments upon several forms of generators are given somewhat in detail, and a list of United States Patents on Calcium Carbide and Acetylene Apparatus from January, 1893, to February, 1898, forms a valuable appendix.

METHODS OF IRON ANALYSIS, Contributed by the Chemists in Charge, and edited by a Committee of the Chemical Section, Engineers' Society of Western Pennsylvania. Easton, Pa.: Chemical Publishing Co. 1898.

The general establishment of chemical laboratories by the manufacturers of iron and steel has led to the accumulation of much practical experience in special lines of analysis, and much of this experience has until recently been retained in the establishments in which it was acquired. During 1896 the Engineers' Society of Western Pennsylvania arranged, by correspondence, to gather the various methods in actual use in the laboratories of the most important furnaces and works about Pittsburg, and the result is this valuable and convenient volume.

The collection includes brief working descriptions of the methods in use for actual work, arranged in such a manner as to represent as correctly as possible the present status of analytical chemistry as applied to iron and steel; methods being given for the following substances:

In Ores,—Silica, iron, phosphorus, manganese;

In Pig-Iron,—Silicon, sulphur, phosphorus, manganese;

In Steel,—Carbon (by combustion), sulphur, phosphorus, manganese nickel.

The laboratories which have thus liberally placed the results of their experience at the service of the public include those of such important works as the Carnegie Steel Co., the Black Diamond Steel Works, the Hainsworth Steel Co., McIntosh, Hemphill & Co., Pennsylvania Railroad Company, W. Dewees Wood Co., and many others, and methods which have received the approval of such establishments will be received with much interest by other workers in the same branch of chemistry.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

C. W. Hunt Company, New York.=Handsome catalogue of steam and electric hoisting engines, especially as used in connection with the coal handling machinery of the same firm. Photographs of numerous installations are shown.

The Watson-Stillman Co., New York.=Illustrated index of hydraulic tools and miscellaneous machinery, containing small illustrations of all the numerous machines made by this firm, with names and reference numbers indicating the sheets in which fuller information is given.

Acme Machinery Company, Cleveland, Ohio, U. S. A.=Catalogue of bolt and nut machinery, including dies, die-heads, bolt cutters, nut tappers, heading and forging machines, and appliances. The machines are well illustrated and full specifications of each are given.

James G. Biddle, Philadelphia, Pa., U. S. A. =Catalogue B., of electrical measuring instruments, illustrating the products of the various makers whose instruments are handled. A great variety of high grade electrical instruments is shown, and many of them are described at length.

Fraser & Chalmers, Chicago, Ill., U. S. A.= Catalogues (*a*) of the "Comet" rock crusher; (*b*) the ball pulverizing mill; and (*c*) of the Sederholm steam boiler, giving in each case detailed and illustrated descriptions of the mechanism and operation, together with testimonials of users.

Sprague Electric Company, New York.=Beautifully illustrated and printed catalogue of the Lundell electric motors, showing the construction of the various types of motors and applications to different machines. Efficiency curves for various loads are given, showing the excellent performance of these motors under widely varying loads.

The Direct Separator Company, Syracuse, N.Y., U. S. A.=A very handsome catalogue of the steam separators, oil separators, ammonia separators, marine boiler separators, and exhaust heads invented by Professor John E. Sweet, giving reports of tests and general information concerning the removal of entrained moisture from steam.

Patterson, Gottfried & Hunter, Limited, New York.=Catalogue of machine tools, machinist's hardware, and supplies for general machine shop use, representing the products of various important establishments.

General Electric Company, Schenectady, N.Y., U. S. A.=Handsome catalogue of enclosed arc lamps, illustrating lamps of this construction for both direct and alternating currents of various voltages. Various methods of suspension and of distribution of light are shown, and general information given.

B. F. Sturtevant Co., Boston, Mass., U. S. A. =A large list of users of the Sturtevant system of mechanical draft, including only the names of those using large plants with engine-driven fans. The list includes many vessels in the merchant marine as well as navy, and also a number of pleasure yachts.

The Waterbury Farrel Foundry and Machine Company, Waterbury, Conn., U. S. A.=Pamphlet catalogue, showing in miniature a large line of sheet-metal working machines described more fully in larger catalogues. The machines are in each case briefly described, and page references given to catalogues in which fuller informatlon may be found.

The Garrett Engine, Boiler, and Machine Works, Garrett, Ind., U. S. A.=Catalogue of the "Model" gas and gasoline engine, illustrating this very simple internal combustion engine, with table of dimensions and prices.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Pamphlet catalogue of the various grades of lead pencils made by the Dixon Crucible Company, attractively illustrated with reproductions of pencil sketches and drawings, and containing an essay upon the use of the lead pencil in artistic work.

The Philippines Company, New York.=A handbook of information concerning Manila and the Philippine Islands, for use in connection with the express and transportation business conducted by the company. An excellent sheet map of the city of Manila and of the group of islands is given.

R. & J. Dempster, Ltd., Newton Heath, Manchester, England.=Handsome cloth-bound catalogue of gas works plant; containing over 300 pages of illustrations and descriptions of all kinds of gas works equipment. In many cases, prices are given, and as the information is very full, the catalogue is almost a treatise on gas works practice, of value to all gas engineers.

James T. Donald & Co., Ltd., Glasgow, Scotland.=Catalogue of tools for engineers, ship-builders, contractors, etc. The catalogue comprises generally all the tools in general use as well as pumps, boilers, engines, etc. Good index and well illustrated.

W. F. Dennis & Co., 11, Billiter St., London, E. C.=General price list of wire, wire ropes, wire fencing, etc., in iron and steel, and also of music wire, bronze, copper and brass wires. The catalogue is furnished with a finger index to the pages. The goods are all made by Felten & Guilleaume of Cologne.

Schischkar & Co., 67, Stafford St., Birmingham, England.=Catalogue of machine tools of all usual shop types, and also of special bicycle making machinery. One section is devoted to engineers hand and sundry tools. The catalogue is a model of the printers art.

Southgate Engineering Company Ltd., New Southgate, England.=Catalogue of machinery

for the manufacture of projectiles with specifications and illustrations.

Clarke Chapman & Co., Ltd., Victoria Works, Gateshead-on-Tyne, England.=(*a*) Price list and catalogue of steam winches, wharf cranes, steering gear and various discharging machinery, including Temperley Transporter. Fully illustrated. (*b*) Circular describing an unbreakable barrel for steam trawler winches. (*c*) Circular describing the "Petersen" water-tube boiler. (*d*) Circular describing Scott's patent steering gear.

Robert Warner & Co., Walton-on-Naze, Essex, England.=Well printed and illustrated catalogue of pumps and pumping machinery; also of wind mills, artesian well boring tools and water works equipment.

Beaumonts Pump Works, Booth St., Edgeley, Stockport, England.=Circular describing Beaumonts Cop Dyeing Machine.

Patent Woolen Cloth Co., Elmwood Mills, Leeds, England.=Price list of felt polishing bobs.

James B. Petter & Sons, Yeovil, England.=Price list of the Petter patent petroleum engine, with illustrations of its application to pumping, etc.

Newton Electrical Works, Taunton, England.=Sheets illustrating electro plating dynamos and electric haulage plants.

Conrad Knap & Co., Ltd., 11, Queen Victoria St. London, E. C.=Circular describing the "Root" watertube boiler.

O. Berend & Co., Ltd., Dunedin House, Basinghall Avenue, London.=Price lists of (*a*) Hartmann and Braun's switchboard instruments, (*b*) micrometers, cylinder gauges, etc.

J. W. Titt, Warminster, England.=Circular describing a wind engine installation in Italy.

Carson & Toone, Warminster, England.=Price list of the "Advance" Oil Engine, with illustrations and description.

David Bridge & Co., King Street Works, Salford, Manchester, England.=(*a*) List of users of Heywood & Bridges friction clutches with illustrations of the different types. (*b*) Larger pamphlet giving fuller details of the clutch, and testimonials from users.

Taylor & Challen, Ltd., Constitution Hill, Birmingham, England.=Illustrated catalogue of presses for all kinds of service and driven by hand, belt or hydraulic power; also of shears, lathes, steam engines, etc.

E. & J. Richardson, Elswick Leather Works, Newcastle-on-Tyne, England.=Price list of leather belting, hose pipes and pump leathers.

The Cape Asbestos Co., Ltd, 8, Minories, London, E. C.=(*a*) Circular describing the blue asbestos removable pipe covering. (*b*) Pamphlet giving list of steamships using the above covering, with results of tests made by the Italian naval authorities and testimonials. (*c*) Folder with prices and statement of advantages.

J. Proctor, Hammerson Street Iron Works, Burnley, England.=(*a*) Circulars describing "Proctors" mechanical stoker and a new system of coking stoker, with usual data as to users, testimonials, etc. (*b*) Circular giving results of the International Competition in France (1894–97) in which Proctors stokers were successful.

National Boiler & General Insurance Co., Ltd., St. Ann's Square, Manchester, England.=Price list of the double cone fusible plugs recommended by this insurance company.

Edwin Verity, 168, Briggate, Leeds, England.=Catalogue of specialties for the building trades, principally metal fittings and accessories for doors and windows.

The Uskside Engineering & Rivet Co., Ltd., Newport, Mon., England.=(*a*) Illustrated catalogue of colliery and briquette making machinery. (*b*) Leaflets illustrating recent designs of electric pumps, hauling engines, coke pushers, etc.

The Unbreakable Pulley and Mill Gearing Co., Ltd., West Gorton, Manchester, England.=Cloth bound catalogue entitled "A Treatise on the Economical Transmission of Power," giving useful data on the pulley, shafting, etc. Also illustrations, full particulars and prices of the various types of couplings, hangers, pedestals, pulleys, shafting, etc., which are the speciality of the firm.

Arthur M. Wild, Sheffield, England.=Illustrated catalogue of engineer's machine tools, including lathes, milling, planing, dulling and shaping machines. The sizes, specifications, and approximate shipping weights are given.

The Electrical Power Storage Co., Ltd., 4, Great Winchester St., London.=Illustrated price list of storage batteries, with full information as to maintenance, method of charging, etc., also full data as to complete sets of storage cells, and sundries for this branch of engineering.

Fielding & Platt, Ltd., Gloucester, England.=Catalogue of the "Fielding" Gas Engine, with illustrations of types up to 100 H. P.; also of the "Fielding" Oil Engine and of gas plants for heating and power purposes.

The Rankine Patent Feed Water Filter Co., 11, Oriel Chambers, Water St., Liverpool, England.=Circular describing the Rankine patent feed water filters.

Browett Lindley & Co., Ltd., Patricroft, Manchester, England.=Circular illustrating and describing the Begtrup Inertia Shaft Covernor.

R. A. Lister & Co., Ltd., Dursley, Glos., England.=Folder describing adjustable tine and link harrows.

Leslie E. Clift & Co., 1, Holborn Place, High Holborn, London.=Catalogue entitled "Wood Engraving for Engineers," showing specimens of work.

Green & Boulding, 105, Bunhill Row, London, E. C.=Catalogue of engineering specialties, including injectors, metallic packings, and valves.

New Conveyor Co., Ltd., Smethwick, Birmingham, England.=Pamphlet containing illustrated description of the Conveyor works and of plants erected by the company.

The Chloride Electrical Storage Syndicate, Ltd., Clifton Junction, Manchester, England.=Illustrated catalogues of (*a*) storage batteries for launches and yachts (*b*) of lighting batteries. Both catalogues are a model of the printers art.

INDUSTRIAL NOTES.

THE equipment of the power house at the lower dam of the falls of St. Anthony at Minneapolis, Minn., is about to be completed, and the necessary arrangements have been made by the St. Anthony Falls Power Co. with the General Electric Co., who manufactured and installed the plant now in operation. The hydraulic work and the power house were finished in the spring of 1898, and five three-phase alternators of 700-k. w. each and two direct current generators of the same capacity with the necessary rotary converters and static transformers were installed. The full equipment of this power plant as originally laid down contemplated the use of eight alternators and two direct current machines of a combined capacity of 10,000 h. p. The present plant has been in full operation since May of last year, the current being used to drive the street and interurban railway systems of the Twin Cities Rapid Transit Co., which operates the electrical railways of Minneapolis and St. Paul. The additional equipment will consist of three 700-k. w. three-phase revolving armature alternators, with rotary converter, step-up and step-down air blast transformers, and switchboards for the generator and converter. The installation of this machinery will raise the generating capacity to the 10,000 h. p. originally contemplated.

THE Safety Insulated Wire and Cable Co., New York, recently received an order for 130 miles of submarine cable, and 6 miles of shore line cable, for shipment to the Philippine islands. An order for 30 miles was also placed with W. R. Brixey, New York. These cables were purchased by the signal office of the United States war department, the awards being given to the lowest bidders who were also able to give quickest delivery.

PLANS for the erection of a four-story brick machine and repair shop, 193½ by 60 feet, for the Baldwin Locomotive Works, on the south side of Buttonwood street, Philadelphia, Pa., have been submitted to the Building Inspection Bureau for approval. Macey, Henderson & Co., have the contract for about $40,000 and have started to demolish the old building, preparatory to starting work on the new structure. The same contractors have been granted a permit to build a two-story machine and smith shop on Hamilton street for the same company. The building will be 169 by 102 feet and will cost about $44,000.

THE Cincinnati Machine Tool Company have purchased all the machinery, patterns and the whole plant, together with the business formerly operated by A. H. Herkhoff & Co., of Cincinnati, Ohio, and will at once proceed in manufacturing tools formerly made by this firm. There will be immediately an enlargement of the plant and the facilities, together with improvements in the tools, so as to place them foremost in their line. The personnel of the Cincinnati Machine Tool Company consists of August H. Tuechter, who for the past fifteen years has been identified with the Bickford Drill & Tool Company, and Mr. Sherman C. Schauer, who for the past ten years has been superintendent of the Hamilton Machine Tool Company.

THE growth of the business of Westinghouse, Church, Kerr & Co., engineers, reaching as it does into many departments and large transactions, has necessitated the providing of additional assistance in the handling of the general affairs as distinct from the daily management of the business of the respective offices. It is the custom of this concern, as far as possible, to advance men from their own ranks and recently the scope of the duties of Mr. Henry J. Conant, manager of the Boston office, have been increased, and while he will continue to reside in Boston, his work will be of a broader nature and be connected with the general affairs of the concern. Mr. Conant has of late been particularly well known in connection with the execution of the large general engineering contract at the new Boston Terminal, of which he had complete charge in both management and engineering. He is a graduate of the Massachusetts Institute of Technology, of the Class of '87, and by his many years of work with Westinghouse, Church, Kerr & Co., is peculiarly well fitted for the larger duties now entrusted to him.

THE large amount of engineering work which has been placed in the hands of Westinghouse, Church, Kerr & Co. during the past two or three years has led to large increase in their force of engineers and other assistants, and involved changes in the position of those who have been long with this concern; chief among these is the appointment of W. W. Churchill to the position of mechanical engineer. Mr. Churchill has been closely associated with all of the largest engineering work of Westinghouse, Church, Kerr & Co., including the Boston Terminal and the Third Avenue Railway Power Plants, and well deserves the place

and title which has been given him. He is a graduate of Cornell University of the Class of '89, and has been with Westinghouse, Church, Kerr & Co. some nine years.

THE Pittsburg Reduction Company has booked an order for a quantity of aluminum for a new telegraph and telephone line to be erected in Manila, Philippine Islands. The order came through Saale & Co. of Yokohama, who are the agents in Japan for the company.

AMONG the most important of the various reports that are annually issued by the iron and steel merchants of Great Britain none is looked forward to with more interest than that of W. Fallows & Co., of Liverpool, which has been issued recently, and in which the output of British pig for last year is computed at 9,000,000 tons. Messrs. Fallows & Co. remark that if the demand for pig increases in the near future as it has done in the past we may see such a rise in prices as will surprise us. It is added that future increase must come mainly from the United States, and that so soon as they realize the strength of their position they may hold out for higher prices.

THE American Wood Fireproofing Co., New York, is building works at Newark, N. J., and will be in a position to fireproof all kinds of timber and lumber needed in naval, marine and architectural work, also all kinds of shingles. The company will sell rights outright for the control of territory, or will give the right to manufacture under royalties, and will superintend the buiding of the works. The officers of the company are: Pres., Guy Phelps Dodge; Vice-Pres., J. S. H. Clark; Treas., Geo. H. Clark, Jr.; Secy. and Mgr., A. Eugene Kirby; Asst. Mgr., Samuel A. Clark.

THE C & C Electric Co., of New York and Garwood, N. J., tell us that they are now experiencing one of the busiest periods in the company's history, and have very recently taken some very large orders for complete electric power transmission systems. Among the most prominent of these installations may be mentioned the following: Naven Linoleum Co., Kearney, N. J., two large switchboards and eight motors, four of them being of a special slow speed type; National Starch Co., Glencore, L. I., 2-80 K.W. belt type generators and a capacity of 130 H.P. in motors; Maryland Steel Co., Sparrow Point, Md., 2-100 K.W. belt type generators, and ten 6 H.P. dustproof motors; Bradley Fertilizer Co., Boston, one 150 K.W. generator, belt type, and a capacity of 140 H.P. in motors and a handsome switchboard.

THE Armstrong Manufacturing Company, Bridgeport, Conn., manufacturing a general line of water- gas- and steam-fitters tools, sharpens and repairs all dies and bits of its own manufacture which may be returned to the factory by gas- and steam-fitters or other users of these tools. Of course, this does not apply to tools in which the teeth are broken to any extent, as the company does not undertake to insert new teeth; although in some cases dies that lack only one or two teeth can be repaired so as to cut threads properly.

WILLIAM E. QUIMBY, 86 Liberty street, New York, manufacturer of the Quimby screw pumps, has received an order for two of his No. 10 pumps, each to have a capacity of from 800 to 1000 gallons per minute, with direct-connected electric motors of sufficient power to pump against 150 lbs. to the square inch. These pumps are purchased by the Chicago City Railway Company, and are to supply water for the largest electric fountain in the world to be erected in a park in the southern part of the city.

THE Brown Hoisting and Conveying Machine Co., Cleveland, O., has been awarded a contract from the Navy Department for coal-handling machinery for the coaling station at Mare Island Navy Yard, California, which is the sixth coaling station for the United States Navy to be equipped with machinery of this company's manufacture, and constitutes all the stations so far awarded. The company has also secured the contract for a 100-ton steel floating crane, weighing over 1000 tons, for the New York Navy Yard.

ACCORDING to the *Indian Engineering*, orders for American locomotives may be expected from Indian railroads. In a recent issue it says: "There is a probability of a new departure being taken by the Government of India in the matter of providing railway locomotives. An order for several engines is likely to be placed with American firms, as the makers in England are so busy that they cannot undertake to complete Indian orders within a reasonable time. The Central Bengal Railway Company have already tried American locomotives, which have given every satisfaction."

THE Charles Hillman Ship & Engine Building Company, of Philadelphia, resumed work February 1st, after the reorganization of the company. The president of the new company is J. J. Hillman, who is also president of the Manhattan Steamship Company, of New York.

THE Jeffrey Manufacturing Company, Colum-

bus, Ohio, who have recently taken up the manufacture of standard elevator buckets and spiral conveyors, report a very flattering trade. Their facilities enable them to supply high-grade material at prices which secure a large trade for this class of machinery.

THE Morgan Engineering Co. report that they have terminated their agreement with the Niles Tool Works Co. for the sale of their product, and hereafter will handle the business direct from their home office, Alliance, Ohio.

THE Hancock Inspirator Co. have named Mr. M. J. Martinez, member of the American Society of Mechanical Engineers, resident agent at Havana, Cuba. The business will be conducted under the style of M. J. Martinez, Consulting and Contracting Engineer, and Mr. Martinez will be prepared to submit estimates on all the different lines of apparatus manufactured by this company.

THE Fulton Engineering and Shipbuilding Co., San Francisco, Cal., it is said, has an order for a 1,500,000-gallon pumping plant and two air compressors from Alexander & Baldwin, Honolulu, Hawaii; a Corliss steam compressor for the Kennedy mines; a 28-in air compressor for the Mare Island Navy Yard, California; a duplex compressor for the Banner mine, Creville, Cal., and a large rock crusher for the new Bown mine, Tuolumne county, California.

THE Kenny Co., New York, has placed its "flushometer" aboard a number of government vessels, among them the U. S. transport Grant. It is equipped with 63 "flushometers," and dispenses with the individual overhead tanks for flushing the closets, which are undesirable for use aboard ship on account of the rolling of the vessel, and as the supply is both irregular and unreliable. With the Kenney system there is one supply tank in the hold and the water is pumped from this at an even pressure through supply pipes to the "flushometer" attached to each closet, which is thus flushed without noise and without wetting the floor.

THE Case Manufacturing Co., Columbus, O., reports that it is busy in its crane department, and has among other orders on hand the following; A 60-ton trolley traveling crane, Portsmouth, O.; a 30-ton electric traveling crane, St. Louis, Mo.; a 15-ton electric traveling crane, Pittsburg, Pa., and a 10-ton hand power traveler, Sanderson & Porter, New York. It has also recently shipped a 15-ton crane to the Toledo Machine and Tool Co., Toledo, O., and has also furnished several wrecking cranes to various railways.

COMPLETE returns of the Bureau of Statistics for December show that month to be another record breaker in the volume of exports of manufactured goods. The whole volume of exports of American manufactures for the month was $28,283,688, which is nearly $2,000,000 in excess of manufacturing exports for November and a trifle in excess of the highest previous month, which was in March, 1898, whose exports were $28,214,450. The remaining months of 1898 never showed manufactured exports of less than $25,000,000, and exceeded $27,000,000 in May and June. It remained for December to carry the total beyond all previous records, making the total for the calendar year $307,924,994 of manufactured goods. This is $28,000,000 more than the exports of 1897, which were $279,616,898, and 54,000,000 in excess of 1896, when manufactured exports were $253,681,541. The total exports for 1898 reached $1,233,564,828.

FROM Japan it is reported that Mr. Kota Nakahara, a graduate of an American college, has formed a cold storage company with a capital of 50,000 yen at Yonago, Hoki Province, Japan. On account of Mr. Nakahara's American education it is expected he will ask for bids from American manufacturers of ice-making and refrigerating machinery, possibly giving them the preference under equal circumstances over other foreign makers

THE Maryland Steel Co.'s statement of foreign business transacted during the year shows that their shipments of steel rails, bars, plates, fittings, etc,. from the Sparrow's Point Works, reached over 100,000 tons. Of this quantity 91,438 tons were shipped to Ireland, India, Africa, Australia, Jamaica, Nova Scotia, Mexico, Barbadoes, Cuba, Russia and Siberia. It is estimated that the shipments of rails and fittings from Baltimore this year will exceed a total of 300,000 tons.

THE "National Directory of Honduras" has just been issued by the Spanish-American Directories Company, Times Building, New York. The work is official in the sense that it was authorized and part of the expense of preparing it was paid by the government of Honduras It is based upon a house-to house canvass, and contains upwards of 20,000 names of individuals, firms and corporations, with their vocations, in over 200 villages, towns and cities of Honduras, and other business information.

IMPROVED MACHINERY

NEW PROCESSES—NEW APPLIANCES

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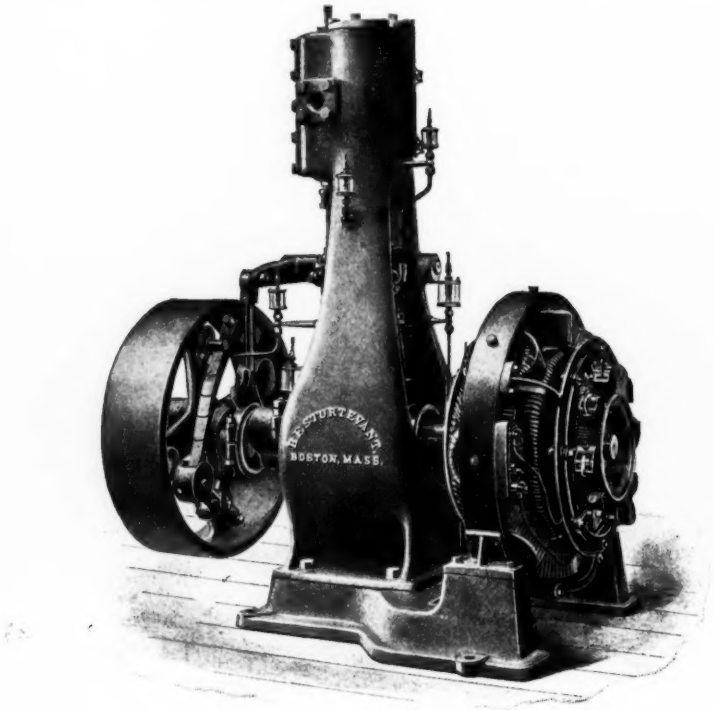
A Compact Generating Set.

IN most cases generating sets are provided with outboard bearings for the armature shafts. In the type herewith illustrated, this extra bearing is done away with, and the armature is overhung upon the end of the engine shaft.

In order to secure compactness, the generator is of the eight pole type, the field ring being of wrought iron, cast steel or cast iron, according to the size of the machine.

The pole pieces of wrought iron are provided with cast iron shoes of such size and shape as to render the machine capable of extreme variation of load without sparking at brushes, or without shifting the adjustment.

The field coils are wound in such a manner as to present the greatest amount of radiating surface, and the armature is built up of laminated steel discs mounted on a cast iron spider, having a hub projection for the reception of the commutator. The commutator is of large diameter, and consists of pure rolled or drop forged segments, supported



STURTEVANT GENERATING SET.

IMPROVED MACHINERY

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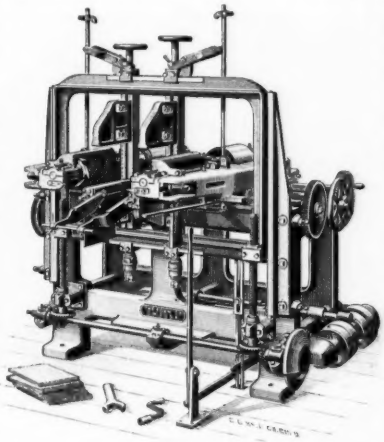
A New Double Lock-Corner Box Machine.

THIS machine, designed and built by the Egan Co., 212 to 232 W. Front St., Cincinnati, O., and known as their No. 1½, is suitable for material from 4″ up to 18″ in length, and any width up to 12″. Several pieces one above the other to a thickness of 8½″ may be cut at one operation, as the clamps open to take material up to 8½″.

In simplicity and in rapidity this machine is far in advance of any other at the present day. The work it does is perfect in every detail—and working both ends, does its work twice as rapidly as a single machine, and each piece is bound to be accurate in length.



The frame is very heavy, webbed on the inside and strongly braced, all parts planed perfectly true and bolted securely together, making a very solid and reliable frame with ample floor space.

The saw mandrels, large in diameter and of the best quality of steel, each running in three self-oiling bearings, have one bearing instantly removable for changing the saws. The mandrel pulleys are each between bearings, and the saws and collars are also between bearings. Both mandrel frames are made to move along planed ways, and one is adjustable to an index by two parallel screws, operated simultaneously by hand wheel and gears, at the end of the machine.

The clamps that carry the boards to be acted upon are on a frame that raises and lowers automatically in planed ways by means of two vertical screws, in front, one at each end of the machine. The jaws for clamping the material are readily adjustable to take in the desired thickness by means of the hand wheels at the top. Suitable and convenient levers stack perfectly the several pieces of material to be operated upon and hold the same until gripped by the automatic clamps, which is accomplished the moment they commence their upward movement. A movement of the lever at the front starts the frame that carries the clamps upward, and they automatically stop and open the clamps as soon as the saws are passed so as to remove the stock. A movement of the lever in the opposite direction feeds the frame back to position, where it automatically stops with the clamps open ready to receive more material.

There are three speeds of feed to the machine to suit either hard or soft wood.

An endless belt is used to drive the mandrels. The binder is adjusted by a hand-wheel and two screws, insuring a parallel movement to same, and it is fitted with suitable springs to give proper tension to the belt at all times.

There is also a larger size, called No. 2, which is suitable for material from 4″ up to 40″ in length, and up to 20″ wide, embodying the same advantages as the No. 1½. The No. 2 has tight and loose pulleys 18″×10½″, which should make 1,000 revolutions per minute.

The Egan Company, 212–232 West Front St., Cincinnati, Ohio, have had a special corps of expert mechanics and draughtsmen at work, for the past year, designing and perfecting new and im-

proved wood-working machines, and this is one of those that they have just brought out and which surpasses anything ever before placed on the market of its kind.

This company make a full and complete line of high grade machines for manufacturing articles of every description out of wood, and they can furnish single machines or complete outfits for any kind of plant with their make of machinery.

Magnetic Incandescent Lamp Holder.

WE illustrate herewith a magnetic incandescent lamp holder, introduced by Jenkins Brothers, New York. Attached to the magnetic holder is one end of a wire of sufficient length to permit of placing the lamp wherever desired. The plug at the other end of the wire is screwed into the lamp socket, and the lamp screwed into the socket in the end of the magnetic holder. The holder is

for use only where a direct current is employed, which, in passing through the holder of the lamp, energizes the magnet, which is of sufficient strength to hold the lamp firmly in any position against an iron or steel surface.

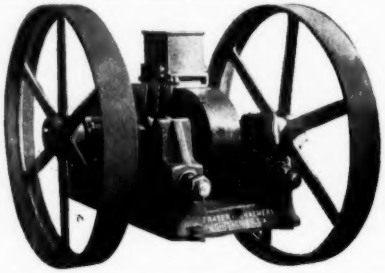
It is evident that such a device is very convenient in machine shops, as the lamp can be placed so as to have the light shine exactly upon the work in the lathe, planer, drill, or other tool. As it can be carried inside boilers and fixed where desired it does away with the always-objectionable torch. In railroad shops it is particularly useful in locomotive repairs, as it can be carried anywhere about the machine, and placed where light is most needed. In the engine room, aboard steamships, about elevators when making repairs, in mines, basements, cellars, vaults, etc., such a portable holder must be found most convenient, and desirable beside, for it eliminates the danger from fire, which is always present with the use of candles and torches.

Fraser & Chalmers Crushing Rolls.

THE accompanying half-tone illustration represents the standard crushing rolls manufactured by Fraser & Chalmers, Chicago, Ills.

These rolls embody all essential improvements, and are designed to accomplish the best results with the simplest construction.

They are of heavy build, mounted upon a solid base all in one piece, like the base of a self-contained engine. The bearings of one of these rolls are framed in one piece with the heavy base, and the bearings of the other are movable in slides planed in the same base. All material is placed where it will be most effective to resist stress, and make a strong and stiff machine.

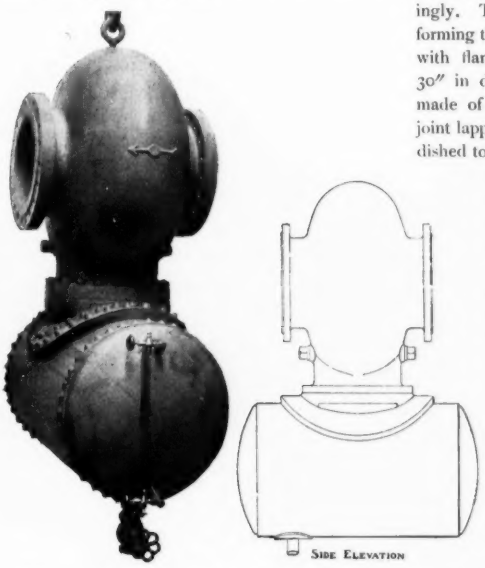


Nests of powerful springs hold the rolls truly to their work with a uniform crushing pressure. The roll shafts are extra heavy, with ample journal surface, and at the same time the necessary flexibility is secured by mounting them in boxes which have finished cylindrical bearings in the frame. This construction permits the passage of an article too tough to crush, such as a piece of steel, and accommodates any unevenness of feed. The cap bolts for bearings are placed in an angular position converging in such a way as to lock one another, and be more secure than caps having parallel bolts. The nests of springs do not have to be disturbed for the removal of shells, rolls or shafts. Their position is stable and unaffected by such changes. By the use of plates on the main bolts the rolls may be set apart positively to any convenient opening.

The feed hopper is provided with inclined baffle plates which distribute the material to be reduced so as to furnish a more even feed. The

cuts show the machine without the housing, which is indispensable for dry crushing, and is furnished when specifically ordered.

The housing neatly covers the rolls, preventing dust from getting into the atmosphere or to the bearings. It is provided with plates and springs bearing against the inner sides of the frames so that the housing has an elastic adjustment to conform with any movement of the roll bearings when these shift in their cylindrical seats, and thus remain dust tight in any case.



SIDE ELEVATION

The size illustrated, 30″ dia. by 10″ face, is of comparatively narrow proportions, which is favorable to evenness of feed, uniform wear and long service. Rolls of good size have greater durability, and render better service than rolls of skimped proportions required to do the same work. These rolls run at the usual peripheral speed of 600 to 800 feet per minute, have a large capacity, depending upon the material crushed, and fineness of reduction. In large concentrating works the course and handling of material is usually such as to make it convenient to divide it between several sets of rolls. It will thus be seen that the range of service for which these rolls can well be chosen is a large one, comprehending both large and small works.

High Pressure "Cochrane" Separator.

WE present above an illustration of a special 18' horizontal high-pressure Cochrane separator, built for the Cambria Iron Company, Johnstown, Pa., by the Harrison Safety Boiler Works, of Philadelphia, Pa. The space between the main steam pipe and the floor being limited, the well or receiver of the separator was turned at a right angle, giving the desired capacity without increasing the depth.

The specifications calling for a separator adapted for an exceptionally high working pressure (250 pounds per square inch), a large factor of safety was adopted and the metals proportioned accordingly. The thickness of the metal in the shell forming the head of the separator was made $1\frac{3}{4}''$, with flanges $2\frac{1}{2}''$ thick. The well, which was 30″ in diameter by 4′ 9″ long over heads, was made of flanged steel $\frac{7}{16}''$ thick, with horizontal joint lapped and triple rivetted; heads $\frac{9}{16}''$ thick, dished to a 30″ spherical radius, with a $2\frac{1}{2}''$ reinforced tapped opening provided for the drip; the cast-iron saddle was double-rivetted to shell, and suitably bolted to the head proper.

In the use of an oblate spheroidal shape, exceptional strength was given, with special protection, at the juncture of the lower branch with the head on the short axis, from expansion and contraction strains, by means of a stay tube cast in and with the head. Through this stay tube is passed a $1\frac{5}{16}''$ bolt fitted at each end with a close ended nut.

The completed separator was hydraulically tested under a pressure of 400 lbs. per square inch.

Hoppes Steam Separator and Oil Eliminator.

THE cuts shown herewith are of a new steam separator and oil eliminator recently put on the market by the Hoppes Manufacturing Co., Springfield, Ohio.

The designer of this separator has endeavored to prevent wire-drawing the steam, and in order to do so has avoided the use of baffle plates or other arrangements of this kind, and thus the steam is not required to take a "centrifugal," "zigzag," "whip-snaping," or other tortuous course through the separator.

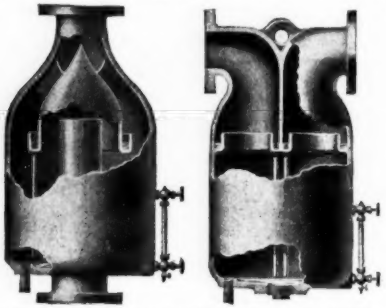
The principal feature of this separator is the troughs or gutters which guard the surface and intercept the water entrained in the pipe.

In the vertical type the water following the surface is carried down and intercepted by the water in the bottom, while the outlet is guarded by the cone. This cone has an annular gutter around its

base, the water from which is carried to the bottom by the pipe shown.

Steam may be passed through the vertical separator either to the right or left, both the inlet and outlet being guarded by gutters, the water from which is carried to the bottom by pipes.

The entrainment being intercepted by the gutters, no water is sprayed off into the steam as



is the case when it comes in contact with obstructions of any kind. This is regarded as an important point, as it is quite evident that to reduce the entrainment at the expense of increasing the saturation is something to be avoided, if possible.

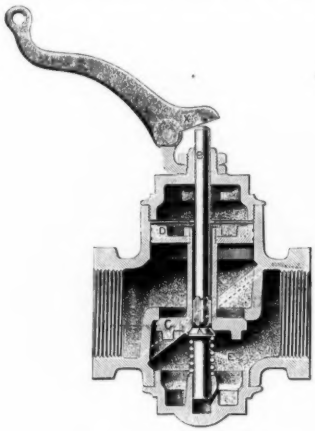
These separators are very large, the working part being ten times the area of the steam pipe. Each separator is in one piece and, consequenly, there is no danger of any part becoming loose from vibration.

Lunkenheimer's Whistle Valve.

THE form of whistle valve shown herewith effectually overcomes the difficulties that steam users have experienced with the old style of valve. Under high pressure it is difficult to operate the ordinary whistle valves, and to keep them tight. In them the disc is not balanced, and as they close with the steam pressure, the continual pounding on the seat soon causes them to become leaky and troublesome.

Recognizing the demand for a more durable and satisfactory valve, the Lunkenheimer Co., Cincinnati, Ohio, have designed the "Lunkenheimer Automatic Balanced Whistle Valve." This valve can be operated very easily under the highest steam pressures, and can be kept tight without difficulty. In this new form of valve the disc is balanced at all times, and when the valve is closing it does not hammer on the valve seat, but closes firmly and without any shock or jar. In opening, the steam pressure acts upon the valve disc in such a manner that the disc is raised from its seat almost automatically.

Reference to the sectional cut will show its operation. The steam pressure on top of disc C normally holds it to its seat. A slight pull on the lever X is sufficient to open the small auxiliary valve A. This admits steam through the opening in the center of stem of valve C to the expansion chamber, where it acts upon the piston D, the area of which being larger than that of valve C forces same from its seat, and allows the steam to pass through the valve. As long as the auxiliary valve A is held open, the main valve C will be kept off its seat, and the valve will be open. When the pull on the lever is released the pressure of the steam closes the auxiliary valve A, and the main valve C closes easily and without shock or jar, as the steam which is entrapped in the expansion chamber tends to cushion and retard its movement. There is very little wear on the two



valve seats, and they can be easily reground by taking off the cap at the end.

These whistle valves are made of gun-metal composition, and are substantially and durably constructed. They are made in all sizes from 1 to 3 inches, inclusive, with screw, flange, or screw and flange ends, and are guaranteed for 175 lbs. working pressure.

IMPROVED MACHINERY

NEW PROCESSES—NEW APPLIANCES

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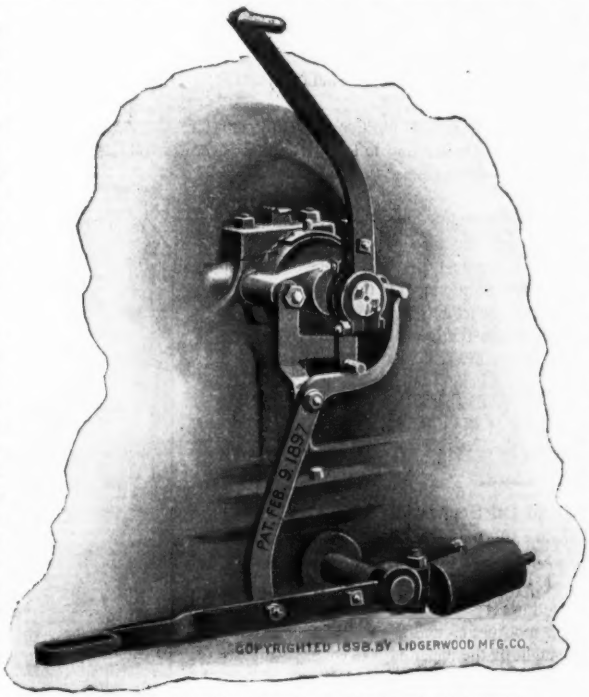
The Lidgerwood Safety Derrick Engine.

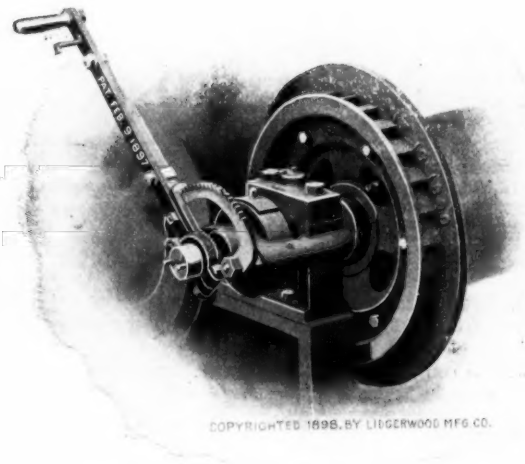
EXPERIENCE has shown in handling a derrick with movable boom, using a double drum hoisting engine, that none but the most expert engine men can be depended upon for rapid work and safe handling, the changes of motion necessary where the maximum capacity is desired being so rapid that accidents more or less serious frequently happen.

With the Lidgerwood safety derrick engine skilled labor is not so much required, and the operator can increase the rapidity of handling the engine with absolute safety to the men below the derrick, and at the same time maintain an erect and natural position. This engine is substantially the standard Lidgerwood friction drum engine with the addition of a safety lever lock attached to foot brake of the boom fall drum and a friction lever latch on the hoisting drum. The friction lever latch on hoisting drum enables the engine man to hold the drum in any desired position, as when taking up a load with the hoisting fall and desiring to lower the boom at the same time. The friction is thrown in on the hoisting drum and it is impossible for the load to drop through any slip or inattention, while the operator may give his whole attention to the lowering of the boom. With the safety lever lock on foot brake of boom fall drum one motion of the foot sets the brake, which cannot be released without throwing the friction in position, and when this is done it automatically releases the foot brake and holds the catch away from the brake till the boom is put in the desired position, when the brake is again set with the foot.



SAFETY LEVER LOCK ON FOOT BRAKE OF FOOT FALL DRUM.

By the old method the engine man had to give his attention to the two friction drum levers, two foot brake levers, two ratchets and pawls and the



FRICTION LEVER LATCH ON HOISTING (FRONT) DRUM.

steam lever, getting himself into a position in which it was almost impossible for him to follow the load and watch the signal man at the same time.

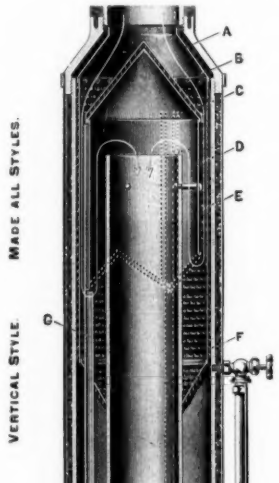
In the "new way" of operating a double drum derrick engine, to which the safety appliances have been attached, the engine man stands erect and in a natural and easy position and is thus enabled to see every signal, whether given from the pit or from the point where the load is dumped, both hands and feet being available for handling the boom while the load is being hoisted.

The Lidgerwood safety derrick engine may be seen at the warerooms of the Lidgerwood Mfg. Co., 96 Liberty street, New York City.

Steam and Oil Separator.

THE accompanying illustration shows a steam and oil separator manufactured by the Direct Separator Company of Syracuse, N. Y., U. S. A. Its operation is as follows:

The accumulated moisture around the walls of the steam pipe is caught by the upper edge of cone A and carried down back of a lining to the water chamber. The current of the steam entering the separator impinges upon the conical surface composed of solid plate C covered with sieve B, through which water may freely pass, but from which it cannot readily escape. Passing through the sieve and depositing on the solid surface of the cone C, this water is carried by conductors to the the water chamber. By means of the cone the column of steam is changed to an annular ring, which is comparatively thin, even while the full area of the pipe is maintained. The steam upon the outside of this ring comes in contact with the lining of the shell, which has a sieve of the same character, as at B, and which catches and entrains any water which may be contained in that portion of the current. There is also provided a lip at the lower edge of inverted cup, which leads all the water that may adhere to its surface down to the conductors to the water chamber. The current of steam passes through the passages indicated by white lines, and is subjected to a whip-snapping action which will throw off any moisture that has not been caught by the surface over which it has passed. The diaphragm

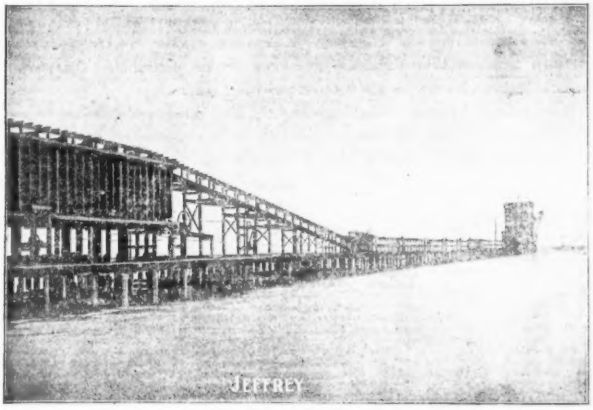


STEAM AND OIL SEPARATOR.

F prevents the steam from picking any water out of the water chamber.

Jeffrey Fish Conveyor.

WE illustrate a portion of a duplicate system of conveyors recently installed by the Jeffrey Mfg. Co. of Columbus, Ohio, each system being 1020 feet long, the longest system of conveyors known to be in existence. The outfit handles fish for rendering and fertilizer purposes, and each system has a capacity of 100 tons per hour running at a moderate speed. At about a quarter mile apart each system is placed on a pier running out in the bay a sufficient distance to give water deep enough



JEFFREYS FISH CONVEYOR.

for unloading vessels of considerable size.

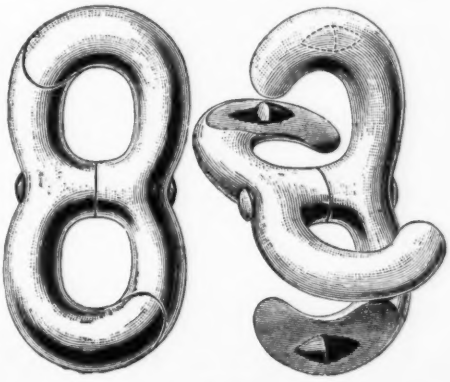
The conveyors are built in three sections, each section being approximately 350 ft. centers. Their detailed construction is, a hard wood flight $24 \times 8 \times 2''$ in size, attached to a single strand of Jeffrey improved drop-forged steel "Climax" chain, with an ultimate strength of 75,000 pounds. These flights are spaced 32" apart, and operate in a Georgia pine trough, thoroughly oiled. When the outfit is in operation the fish are taken from the vessel by an adjustable elevator, and spouted into a receiving bin; from this bin they are dropped onto the initial conveyor of the system, which carries them its length and delivers them to the second conveyor. This conveyor carries them forward its length and delivers to the shore conveyor,—which rises gradually to a height of 25 feet crossing the top of a 150-ft. storage bin into which it drops its load at such intervals as may be desired.

From the storage bin they are distributed into the works by other machinery as wanted. The initial and middle conveyors are driven by Manila-rope transmission, 600 ft. centers, taking power from a jack shaft placed at the head end of the sorage bin. A 60 h. p. automatic engine is used to furnish power for each system. The timber work is of the best long-leaf Georgia-pine, framed and bolted securely throughout to guard against the heat, and damage from the high winds prevailing a large part of the year at the sea-shore.

The Keystone Open Links.

THE Keystone Open Link, manufactured by the Keystone Drop Forge Co., Philadelphia, Pa., s claimed to be the strongest, most durable and simplest patented open link in the market; the two centrally pivoted halves are drop forged from bar steel, and when closed the abutting lugs prevent the lateral displacement, or rendering of the link, to such a degree as to make them about as strong as the solid welded chain of equal size.

These links are used in the mining, lumber ing, railroading, shipping and draying industries—in fact wherever chain is used, and will last as long, if not longer, than the chain, owing to their being drop forged from bar steel, and their simplicity of construction, is such as to permit of their instant adjustment, without any tools whatsoever—an



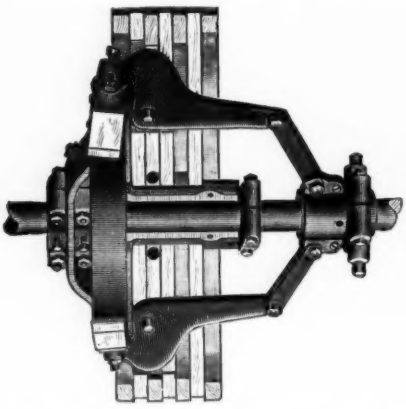
KEYSTONE OPEN LINK.

invaluable feature, when time, money, and life are in jeopardy while making a repair.

The Keystone Drop Forge Co., also manufactures a full line of wrenches, hoist hooks, eye bolts, etc., as shown in their illustrated catalogue, sent on request, as well as devoting a large part of their plant to the making of drop forgings of special design, in iron, steel, copper, and bronze.

The Reeves Wood Split Pulley Clutch.

IT is a fact well understood by machinists that, in many places, it is very difficult and expensive to run a loose pulley at all. Space does not permit enumeration of the causes of such annoyance; suffice it to say, that ever since loose pulleys have been in use, the manufacturers of pulleys have been trying to design a satisfactory boxing. The problem is yet so far unsolved that an inexpensive



clutch remains a most welcome practical device for such cases.

The expense of the loose pulley, of the driver having a face twice the width of the belt, of the wear on the belt occasioned by constantly shifting it, of the power necessary to run the driver and loose pulley continuously, whether the machine is in use or not,—all are items of such significance that a clutch would unhesitatingly be substituted were it not for the explanation just given.

The simple mechanism adopted in the Reeves clutch, adapts it for use wherever a tight and loose pulley has heretofore been necessary.

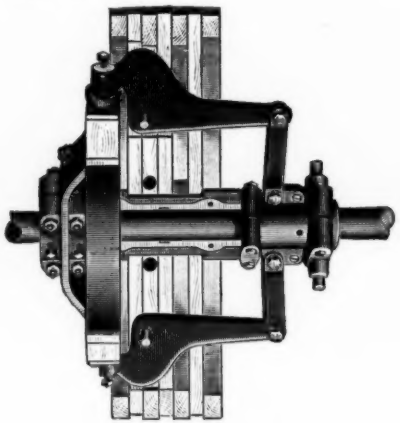
The first expense of the clutch will be found little, and, in some cases, no more than the extra width of driver and loose pulley, and the saving in belt and power alone will pay for the clutch in a short time.

Every argument favoring the use of wooden split pulleys in preference to those made of iron or steel, is equally applicable to the Reeves clutch as against steel- or iron rimmed clutches. The principle of construction is the same, the arms only being strengthened, so that a perfectly solid fulcrum may be created for the shoe lever.

It can be attached to the shaft by an ordinary factory employé. There is nothing to wear out excepting the friction shoe and the boxing, either of which may be replaced for a few cents, and without trouble. All parts requiring any possible adjustment stand still when pulley is not in clutch.

Every clutch, and every pulley to which it is attached, is split, and can be placed upon the shaft in the briefest possible time.

Catalogues, price list, and special information will be supplied by the manufacturers, the Reeves Pulley Co., Columbus, Ind.



A New Belt Dressing.

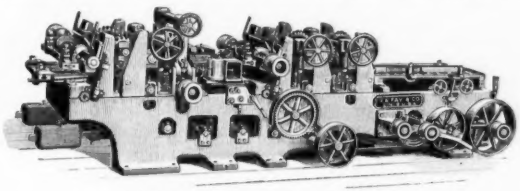
THERE has been a growing demand among belt users for a more convenient form of belt dressing than the paste. The Joseph Dixon Crucible Company, Jersey City, N. J., are now placing on the market a solid belt dressing in round bars, about 8 inches long and 2 inches diameter. It makes a package convenient to the hand, and easy to apply even to fast running belts. The company does not claim that the solid dressing is as good a preservative of the life and elasticity of the leather as the Dixon paste, but it is quick to apply and quick to act, and that is what is wanted by the general run of belt users.

The "Lightning" Flooring Machine.

THIS No. 7 new six-roll triple-cylinder "Lightning" flooring machine herewith illustrated is the

latest in the field, and, as new and important improvements have been incorporated in it that have never before been assembled in any one machine, it can not otherwise than prove of interest to all who are engaged in manufacturing flooring, ceiling, siding, casing, etc. It is made in two sizes, to plane four sides 10″ and 15″ wide and 6″ thick. The framing is massive, strongly braced inside to resist all strains and vibration; has heavy girts, so placed as to come under the working parts of the machine where there is the greatest resistance. All surfaces are accurately planed and securely jointed. By a system of interchangeable parts and adherence to exact standard sizes, the makers have brought the machine to a greater degree of perfection than ever.

The cylinders are three in number made from solid steel forgings of fine quality, have four faces slotted to receive two or four knives, and chip-breaking lips for working cross-grained lumber. The first or main upper cylinder is mounted in a heavy yoked frame, has journals 2¼″ in diameter, and runs in self-oiling bearings 10½″ long.



"LIGHTNING" FLOORING MACHINE.

It has double-flanged pulleys close to bearings on each end, fitted on taper bearings, secured with wrought nuts. The cylinder-raising screws are outside of the frame, and are fitted with ball bearings and a device for quickly taking up all lost motion in the screw caused by wear of the threads. The lower cylinder is mounted in a heavy yoked frame, has 2¼″ journals that run in self-oiling bearings 10¼″ long, and is vertically adjustable at each end. It is driven by flange pulleys at each end. The second upper cylinder is placed at the feeding-out end of the machine, and is intended for a light or skimming cut, and constructed to revolve at a much higher rate of speed than the other cylinders. The journals are 1¾″ in diameter, and run in yoked bearings 10½″ long. It is single belted and driven from the first upper cylinder.

The matching works are heavy. The arbors are of steel 1¾″ in diameter where the cutter-heads are applied, and revolve in long, self-lubricating bearings, both of which are adjustable vertically and horizontally, and are rigidly locked in any desired position by a lever conveniently located outside the frame. The top plate of each matcher hanger is detached from the main casting for convenience and economy. Will match stock as narrow as 1½″. Our patent weighted matcher clip has adjustable toe, is hinged to the matcher hanger, and produces uniform pressure on the material. Shaving hoods are provided, which can be swung out of the way to give access to the heads.

The feed works consist of six large feed rolls, 8″ in diameter, driven by a train of powerful gearing, each gear on a shaft extending through the machine and running in babbited bearings. The expansion gears on feed rolls are inside the frame, and run in bearings. The screws for raising the rolls do not revolve, the rolls being mounted in sleeve housings that travel on the screws. This makes the roll adjustment very easy, as the pressure weights do not have to be lifted. All roll boxes are long and large in diameter. The feed-out roll is covered and provided with scrapers. The weight levers are inside the frame, and move with perfect freedom. Three speeds of feed are furnished,—viz., 30′, 45′, and 60′ per minute. The feed is under instant and positive control of the operator by means of a lever engaging a ring friction.

The pressure bar before the first upper cylinder is adjustable to and from the cut, and has a chilled toe, reducing wear to a minimum. The bar after the cut is adjustable for difference in thickness of material worked. The bars before and after the lower cylinder are adjustable to and from the cut, and are vertically adjustable for varying depths of cut. The bar over the lower cylinder is adjustable on heavy stands, and securely locked in position. It can be instantly swung over from either side by simply loosening one nut. The bars before and after the second upper cylinder are adjustable to and from the cut. The bed plate for this cylinder is arranged with an adjustment for the cut of the lower cylinder. A continuous pressure bar extends over the matching works with independent adjustment, and can be quickly thrown out of the way to give access to the heads.

This machine is equipped with a new and improved belt-tightening apparatus for both cylinder and side-head belts, quickly adjustable while the machine is running, and permitting the use of endless belts, that run more smoothly and do not require to be cut for the stretch to be taken up. By the use of this apparatus 1½″ stocked may be matched, and the belts stand at least 10″ apart on the countershaft. The name "Lightning" is the trademark, and the exclusive property of the makers.

There is a shop number on each machine and a number on each casting by which they may be identified, and should be mentioned in ordering supplies. The builders are J. A. Fay & Co , Cincinnati, Ohio, who will be pleased to give fuller information.

The "Pittsburg" Water Meter.

THE illustration herewith is of the "Pittsburg" Water Meter, the style which has recently been adopted for use by the city of Chicago, and is now being supplied by the manufacturers, the Pittsburg Meter Co., East Pittsburg, Pa. The working parts of this meter are made of a special alloy of non-corrosive composition, also of such nature that the wear is reduced to a minimum. The outer casing in sizes up to and including 1″ is of bronze; in larger sizes it is made of galvanized iron. The bottom plate in all sizes is galvanized iron, while the measuring chamber, which encases the working part, is made of bronze in all sizes. The bottom plate is so designed that if the meter is frozen it relieves all other parts, and can be replaced at a low cost. The intermediate train, common to this meter only, insures lightness of running aud absence of friction, while

retaining great strength. The circular dial, which has been used by the manufacturers with great success for many years on both water and gas meters, does not stick, as may happen with the straight register. The manufacturers will be glad to furnish diagrams and other additional information to interested inquirers.

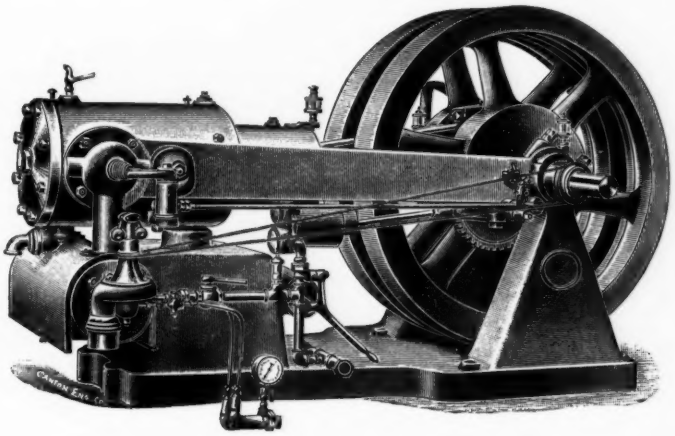
IMPROVED MACHINERY

NEW PROCESSES—NEW APPLIANCES

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Priestman Safety Oil Engine.

THERE is a class of internal combustion motors for which prominent scientific men have, for some time past, predicted a brilliant future ; but which, until comparatively recently, have baffled experimenters in their efforts to overcome several obstacles We refer to the safety oil engine, and by the term "safety," mean engines which use for fuel the heavier and safer constituents of crude petroleum, instead of the lighter and explosive products such as gasoline, commonly used.



The Aultman Company, of Canton, Ohio, have recently taken up the manufacture of the Priestman Safety Oil Engine, which has a number of advantages over gas and gasoline engines, and which works very successfully. The engine operates upon the well known four-cycle gas engine principle; that is, in the single-acting single-cylinder engines, one impulse is received for every two revolutions of the fly-wheels. In several respects this engine differs from ordinary gas engine practice, the chief departures being in the kind of fuel used and in the method of using this fuel. Only such oils as are ordinarily burned in house lamps are employed. The chief obstacle which prevented earlier success with oil engines was the tarry residuum left upon gasifying the heavier oils and which, sooner or later, clogged the valves and other inner parts. By burning the oil according to the Priestman method, however, this obstacle is so effectually overcome and such perfect combustion is obtained, that engines have been constantly run for over a year without any necessity for cleaning the valves and without collecting any injurious deposits. Another noteworthy and distinctive feature is the method of cylinder lubrication, for which, curiously, no means is provided. When the working charge is drawn into the cylinder, the walls of the latter become coated with kerosene, which furnishes not only a positive but also a most effective lubrication. By reason of this method of cylinder

lubrication, the cooling water surrounding the cylinder can be allowed to boil, and with beneficial results. For portable engines and in places where small water tanks are advisable, the ability to use boiling water is most advantageous, as it is only necessary to have sufficient water to always insure the cylinder jacket being full. The steam engine method of governing, that is, by throttling the charge, is employed. By thus proportioning each charge of oil spray and air to the load carried, and by taking impulses regularly, no matter whether the engine be running light or fully loaded, the best regulation of speed is obtained, and the engine is therefore particularly adapted for work such as electric lighting, where constant speed is an indispensable factor.

Reference to the cut will show that the engine is designed upon the "straight-line" principle; that is, the fly-wheels are mounted between the main bearings. By having the fly-wheels in this position, the bearings are relieved of a tremendous twisting strain, a fact evidenced by the minimum of wear and of lubrication required. The valves are of the poppet type, the exhaust being shown upon the right of the cylinder head. This valve is worked by a lever, rod and cam. The inlet valve, which is diametrically opposite the exhaust valve and not shown in the cut, is opened by atmospheric pressure. A small air pump, worked by an eccentric, forces the oil, under a pressure of about 8 lbs , from its tank, placed wherever convenient, into the spray-maker, which is directly under the governor. The chamber, shown underneath the cylinder head, is the mixer into which the oil is sprayed and where the spray is mixed with the proper amount of air for supporting combustion. The hot exhaust gases pass through an annular space surrounding the mixer, and their heat, which would otherwise be wasted, is utilized for heating the oil spray and air before it passes into the cylinder. One of the strongest claims made for the engine is that of safety; this, of course, would be expected from the nature of the fuel used. Having few working parts, being simple in its method of operation, and perfectly automatic in its action, a minimum of attention is required, and the engine is most durable and trustworthy.

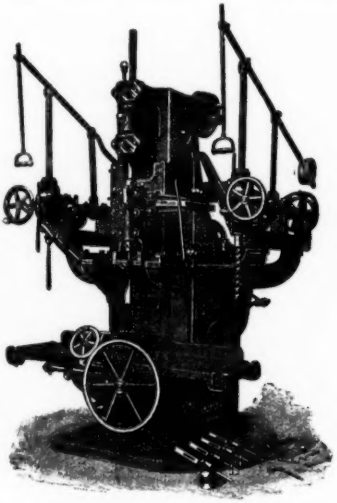
The Aultman Company have added a number of improvements to the engine, among them being an air storage system, whereby engines can be easily started without recourse to any preliminary hand pumping or turning of the fly-wheels.

If the engine will fulfill the claims made for it, it should satisfy a long-felt want in many localities. The Aultman Company will be glad to supply further information on request.

New Vertical Hollow Chisel Mortising Machine.

J. A. FAY & Co., 271 to 292 W. Front St., Cincinnati, Ohio, have had a special corps of expert mechanics and draughtsmen at work for the past year designing and perfecting new and improved wood-working machines. One of these just brought out, which surpasses anything ever before placed on the market of its kind, is the No. 4 Vertical Hollow-Chisel Mortising Machine with auxiliary boring attachment.

To those who are engaged in making and repairing railway cars, wagons, agricultural machinery, or anything requiring heavy mortises, this new machine will certainly prove of interest, since it is a most powerful and reliable mechanism. The greatest care



has been exercised to incorporate in this machine the essential elements of a strong, simple and efficient mortiser, that produces its results to the entire satisfaction of the operator, and without the necessity of laying out the work or cleaning he mortises.

The frame is massive, made in a cored form with wide base, giving good floor surface, and carrying a cored housing, and with it the chisel-ram, the auxiliary boring attachments, and the timber-supporting table. The housing is gibbed firmly to the frame, with provision for taking up wear, and has a lateral movement, actuated by a lever, for moving the chisel to its required position

above the timber. It is counterbalanced by a weight and lever, and supported on rolls which reduce the friction to a minimum in operation.

The chisel-ram is gibbed to the housing, and carries the boring spindle that prepares the material for the chisel-thrust; this boring spindle runs in a long, self-oiling bearing in the frame, and through the sleeve, bearings and pulley on the housing where the power is applied. There is a self-adjusting binder provided for always keeping the proper tension to the belt that drives the boring spindle. There are stops provided to regulate the vertical travel of the ram for the depth of mortise, and also for the lateral movement for its width. The vertical movement of the ram is 16″, and the extreme lateral motion, with the housing, is 14″.

The table for supporting the material is 4′ 0″ long. It is provided with stops to regulate the travel to the length of the mortise required; is operated by a handwheel, rack and pinion; has an adjustable clamp for holding the material firmly in position, and a vertical adjustment. The reciprocating motion of the chisel-ram is produced by reversing friction and gearing. The countershaft is placed above the machine, driving the friction by two belts, and also driving the boring spindle on the frame, and the auxiliary boring attachments.

The auxiliary boring attachments are placed one on each side of the frame, at such distance from the chisel as will permit of adjusting them to an angle of thirty degrees in either direction. These are convenient for joint-bolt boring, and save much handling of material. The spindles have a vertical adjustment of 20″, and a lateral adjustment of 12″.

Each machine bears a shop number, and each casting is numbered, so that parts may be easily identified, in ordering supplies.

This Mortiser is furnished, if desired, with a steel traveling bed of any required length, and having both power and hand feed, adjustable stops for gauging the distances it travels, and quick-acting eccentric clamps for holding material firmly in position.

A full and complete line of high-grade machinery for manufacturing out of wood articles of every description is made by this company, and they are always as ready to equip a complete wood-working plant of large size as to supply a single machine. Full information will be gladly given of the above or any other improved wood-working machinery, and special prices quoted, in response to the inquiries of those who desire the best in wood-working machinery.

A High-Grade Chuck.

THE accompanying figures illustrate a particularly good example of American workmanship in fine tool manufacture—a positive driving drill chuck, made by the Pratt Chuck Company, of Frankfort, N. Y.

Under modern conditions of exact lathe and milling work, the chuck which holds and drives the drill, boring tool or reamer, should be a thoroughly workmanlike and durable tool. This is especially important for all uses of chucks on drill presses and turret machines for turning out large orders and true-to-gauge work.

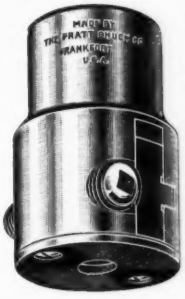


Figure 1 is a general view, and Figure 2 a clear representation of the working parts of a chuck successfully designed to meet such conditions. The distinctive feature of the tool is an equalizing driver, which takes the flattened shank end of the drill, or other working tool. This driver consists of a cross-bar pierced with a rectangular socket-hole, indicated in both figures, lying in the base of the chuck. By the use of this device, the jaws of the chuck have only to hold the working tool in perfect alignment, and are wholly relieved of the twisting strain of driving the tool as well, which so soon spoils an ordinary chuck on heavy work, using drills or reamers of large diameter. The end of the tool shank need not be accurately or centrally flattened, as the body of the chuck is hollowed out sufficiently to fit loosely about the driver, in order to allow an imperfect shank to find the socket and be positively driven by it. It is impossible for a tool to slip, and the jaws need be tightened only enough to allow the tool to float—a handy feature when the chuck is in use on worn lathes where the turret holes are out of line. Perfect work on a finishing cut, it will be readily appreciated, can thus be done on an old and imperfect machine.

The use of the positive driver here described is facilitated by the fact that leading drill makers furnish drills and reamers with properly flattened

shank-ends, if desired, without extra expense over ordinary round shanks. Taper shank drills with flattened ends are perfectly held by the driver, the jaws bearing for alignment grip on a special taper steel split sleeve made for these chucks.

The chucks are made in five sizes, adapted for tool shanks from the smallest up to 2 inches in diameter. The working parts are well made of tool steel to standard gauges, which insures perfect interchangeability, and are tempered to reduce wear to a minimum The bearing threads are heavy and truly cut, and the jaws are surface-ground after tempering, ensuring accuracy. Jaws and screw can be removed without taking off the face-plate of chuck.

The Pratt Chuck Company's tools have received the hearty endorsement of leading manufacturers and high commendation, after trial, from the Department of Mechanic Arts of Cornell University.

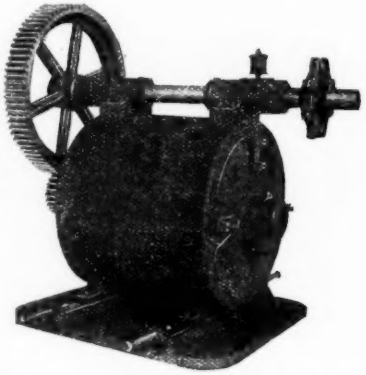
Backgeared Motors.

THERE are doubtless many machinery builders and manufacturers using electric power transmission, who would use more electric motors in direct connection with their machinery, tools, etc., were it not for the cost of motors designed to operate at very slow speeds.

The term "direct-connected" motor generally implies that the motor is to have its armature shaft directly coupled to the main driving shaft of the machine or tool, and that the normal armature speed is to be the maximum speed of the machine shaft. In a problem of this kind, where the speed of the machine shaft is lower than, say, 600 revolutions per minute, the use of a motor of an expensive type is involved.

Naturally, the best and most efficient method is that of using a special slow-speed motor with many poles; but as the expense thereof is often prohibitive, many persons who would otherwise use motors in such cases decide to do without them.

The second best method—one which seems to have been making great strides in popularity recently—is to use what is now known as a "backgeared" motor. The C. & C. Electric Company, New York, are producing a line of these back-geared motors, in sizes ranging from 3 to 40 h. p. which seem to be in very general use. The motor itself is of their four-pole ironclad pattern, and of either their open or entirely enclosed type. The field frame which forms the case of these motors is of cast steel of cylindrical form, and is splendidly adapted to carry the pillow blocks, which are bolted thereon in any location desired. A rawhide pinion is placed upon the armature shaft, which meshes with a cut iron gear carried upon the back shaft supported in the pillow blocks. Through the variation of the sizes of the gears almost any desired reduced speed, within reasonable limits, may be given the back shaft. This method of reducing the speed is one which involves a very slight loss of power, the loss depending to a great extent upon the smooth working of the gears. This



loss, due to friction, with a good set of gears amounts ordinarily to but little over two or three per cent—rarely as high as five per cent. Moreover, a back-geared motor of this kind, being entirely self-contained,—is portable; its gears take up but little extra room; it makes but little noise; the ratio of the speed reduction may be readily changed with change of gears; it may be placed on floor, wall or ceiling; its back shaft may be coupled, geared or belted to the machine or line shaft, all of which advantages should be well considered. In fact, in the majority of cases, such a motor as this will answer the requirements equally as well as a very expensive slow-speed motor, specially designed for direct connection.

Those interested in back-geared ironclad motors may learn all about them by communicating with the C. & C. Electric Company, 143 Liberty Street New York.

INDUSTRIAL NOTES.

The Riter-Conley Company, Pittsburg, Pa., have a contract for cyanide tanks for the Gold Hill Mining Company, Johannesburg, South Africa, to cost $30,000.

The Detroit Graphite Manufacturing Company announce the removal of their New York office from 256 Broadway to the St. James building, Broadway and 26th street.

The C. & C. Electric Company announce the change of address of their Philadelphia office, from 633 Arch street to larger and more attractive quarters at 45 North Seventh street.

France is a liberal purchaser of American machinery. Two December shipments to Havre included $20,000 worth of metal-working machinery by one steamer and more than $42,000 worth of iron and wood working machinery.

Orders for 16 more locomotives for the Imperial Railway of China have been received by the Baldwin Locomotive Works, Philadelphia, besides 30 for the Reading, 10 for the Chicago & Northwestern, 10 for the Midland Railway, of England, and various smaller orders.

The demand for electrical machinery for the South African market continues to be strong, while there are indications of an increasing demand for mining machinery and manufactured iron. Possibilities will become certainties, if merchants and manufacturers unite in sustaining trade.

Rafael de la Mora, M. E., of Guadalajara, Mexico, has formed a partnership with Guadalupe López de Lara, M. E., under the firm name of Mora and López de Lara. The new firm will push energetically the sale of machinery in Mexico, from their headquarters in Guadalajara.

The Laidlaw-Dunn-Gordon Company, Cincinnati, have shipped to Shanghai, via New York and the Suez canal, four carloads of machinery, consisting of two cross-compound condensing pumping engines, with condensers, boilers and other equipment, for the Shanghai Inland Water Company.

Owing to the high prices of copper, tin, etc., the Phosphor-Bronze Smelting Company, Limited, of Philadelphia, have withdrawn all quotations on Phosphor-Bronze, Delta metal and other alloys in manufactured goods, ingots and castings. Orders for their goods will be filled, for the present, at such prices as are warranted by existing conditions.

A new use has been found for the corrugated steel sheets commonly used for roofing purposes, the Cincinnati Corrugating Company, of Piqua, Ohio, having supplied a considerable quantity of its product for compartment partitions in the cruiser Wisconsin, now in course of construction by the Union Iron Works, at San Francisco, Cal.

The American Engine Company, Bound Brook, N. J., manufacturers of American-Ball Engines and electrical machinery, by reason of the growth of their business, have felt for some time the necessity of an office in New York City. This they have met by taking quarters at 95 Liberty street, placing them in charge of Mr. Edwin T. Boyer, formerly of Philadelphia.

The Snow Steam Pump Works, of Buffalo, have appointed as resident agent at Havana, Cuba, Mr. M. J. Martinez, member of the American Society of Mechanical Engineers, who will conduct the business under his own name. Mr. Martinez will also respresent the Aultman & Taylor machinery Company, of Mansfield, O., in the sale of Cahall water tube boilers.

When it is considered that it is less than ten years since meters were first used to measure the consumption of electricity, their present universal use is the more remarkable. Some idea of the extent of the meter business may be gathered from the fact that not less than 200,000 Thomson Recording Watt motors alone have been manufactured and sold by the General Electric Company.

The Fort Wayne Electric Corporation, Fort Wayne, Ind., have sustained a loss in the death of Ranald T. McDonald, late president and general manager of the company, which occurred at Dallas, Texas, December 24th. However, the business affairs of the company, it is announced, will not be materially affected by his death. Charles C. Miller, secretary and treasurer, will act as general manager until Mr. McDonald's successor is chosen.

The steamer Servia, on her last trip to Chinese and Japanese ports, took an extraordinary cargo of manufactured iron material for those countries, among which were, for Shanghai, $16,000 worth of iron pipe, $14,000 worth of pig iron, $15,000 worth of boilers and engines, $10,000 worth of steam heating apparatus, $15,900 worth of machinery tools; and for Yokohama there were shipments of $28,000 worth of rails and upward o $6,000 worth of track material.

The Commercial Electric Company, Indianapolis, Ind., have recently installed a complete lighting and power plant for the Omi Mashi-Boseki Kwaisha, Kioto, Japan, which is a large flax spinning mill. All the machinery and supplies furnished were of American manufacture, and installed through the Commercial company's agent, Paul G. Fiedler, Yokohoma. This is the fourth plant installed by the Commercial company in Japan within the last few months.

The Pratt & Whitney Company, Hartford, Conn., have furnished through their British agents, Messrs. Buck & Hickman, a complete bicycle plant for the Yorkshire County Cycle Company, of Leeds, England, the cost of which is placed at $75,000. A significant fact in connection with the award of this contract is, that English firms wanted to supply only what they thought the cycle company should have, and this determined the placing of the order in this country.

The Chicago branch store of the J A. Fay & Egan Company has been sold to Manning, Maxwell & Moore, of New York, and the latter firm have removed from their former location, 60 South Canal street to 22, 24 and 26 South Canal street, where the purchased stock of the J. A. Fay & Egan Company was located. The latter firm has been appointed exclusive sales agents for Chicago territory for all of the wood-working machinery of both the J. A. Fay Company and The Egan Company departments.

The Lombard Water Wheel Governor Company, Boston, Mass., report that the demand for their governors is constantly on the increase. During last month they received orders for upwards of twenty governors, to regulate forty-one water wheels, which will develop 15,750 horse power. More than half of this machinery is to be used in electric stations—principally in power transmission plants—and electric railway plants, the balance being in textile and other manufacturing plants driven by water power.

An electric power station is being erected at Portsmouth, N. H., by the Boston & Maine Railroad Company. The building is 118 feet wide and 64 feet long, with side walls of brick. The roof is of fireproof construction, with steel trusses supporting steel beams for the purlins, on which a roof of concrete is to be laid. The Berlin Iron Bridge Company, East Berlin, Conn., has the contract for the steel work. The same company is supplying the steel work for the new plant of the United Gas Improvement Company, of Gloversville, N. Y.

The award of a gold medal to the Buffalo Forge Company by the Omaha Exposition authorities was a graceful recognition of the splendid performance of the company's engine in the power plant of the exposition. Instead of the engine being run the length of time specified in the contract, it was found necessary to extend the time of its operation to 24 hours per day continuously, by reason of breakage in some of the engines, caused by the faulty steam main. That the engine was equal to the arduous service imposed upon it is shown by its continuous work without stoppage for repairs of any kind.

The Cambria Steel Company have leased the works of the Cambria Iron Company, at Johnstown, Pa., and have consolidated their New York offices, formerly at 100 Broadway and 33 Wall street, at 71 Broadway, in the new Empire building. Mr. H. L. Waterman has been appointed general sales agent for New York and vicinity, and he will devote special attention to the sale of structural steel, steel blooms, billets and slabs. Mr. W. A. Washburne will conduct negotiations for steel rails and railway track fastenings, and Mr. L. R. Pomeroy will give attention to steel axles and other forging specialties.

Reliable advices from Hamburg indicate that the prospects for business from Germany in the engineering, iron and steel lines are most encouraging. In every branch of these trades they are working overtime, and it is expected that the demand for new tools and machinery will be larger than ever. In January an order for 300 locomotives was given to German manufacturers by the Prussian State Railways; and during the present year no less than 1,000 locomotives are to be ordered. It is evident, therefore, that the lively period in industrial Germany will bring a large demand for American labor-saving machinery.

Recent changes in the General Electric Company place Mr. W. J. Clark in the position of general manager of the foreign department, with headquarters in New York. Mr. Clark succeeds Mr. D. Mazenet, for the past five years general manager of this department, who becomes managing director of the Mexican General Electric Company, with headquarters in Mexico City. In view of the enlarged opportunities for foreign trade, the scope of the foreign department will necessarily be greatly widened; and in Mr. Clark's hands, it will, in all probability, become the most important of all the company's departments.

It is announced that American manufacturers

will shortly have opportunities to bid on large quantities of corrugated galvanized iron and electrical goods for the Brazilian market. In the Argentina trade possibilities lie before American manufacturers who will conform to the metric system of measurements. The report of the special commissioner of the British Board of Trade, appointed to inquire into the prospect of British trade in certain South American countries, is to the effect that the failure of British manufacturers to use the metric system, especially in estimating for engineering work and the like, is a great drawback to British trade in the Argentine Republic.

The new year shows a degree of prosperity and a magnitude of business totally unprecedented in the history of the iron and steel trade. Prices continue to show a heavy advance all along the line. The home trade is by far the largest that has ever been known, while the export trade has assumed very important proportions. The position of the market is a good deal stronger than it was a year ago, because we have produced very close to 2,000,000 tons more than we did in 1897, while our stocks are about 180,000 tons less, showing conclusively that we are now getting rid of over 1,000,000 tons of pig iron a month. This, of course, gives a basis for higher prices during 1899. Prices are slowly but steadily advancing.

Not only are American-made steel rails, plate and many other bulky manufactures of iron supplanting those of English make in the British dependencies, but small articles, such as bolts and nuts, made here, are finding easy access to the same markets. A well known English firm has just addressed a circular to the bolt and nut manufacturers in which they complain that the American seller is underselling them, stating further: "The quality of the bolts and nuts is fully equal to the very best quality made in this country. Most of our largest customers for bolts and nuts in Australia and South Africa have ceased ordering from us, informing us that they are purchasing from the United States; and others, while sending us their orders, instruct us to purchase from America as long as prices are so much lower than in England." Just now we are sending more bolts and nuts to the British markets than ever before.

The New York Air Brake Company has obtained a trial order from the Russian Government to equip twelve freight locomotives and two hundred freight cars with their air brake, for which the price paid will be $25,000. This contract was obtained in competition with French, German and Russian companies. The Westinghouse air brake has been in use on passenger trains in Russia for about two years, and the Westinghouse Company has purchased a building in St. Petersburg and is now putting in a plant to fill a trial order similar to that given to the New York Air Brake Company. Should the order given the latter company prove satisfactory, it will also build works in St. Petersburg. There are said to be mechanical difficulties to be overcome in adapting the air brake to the freight locomotives and cars in use on Russian railroads, but should they be overcome the entire freight equipment, consisting of 10,000 locomotives and 500,000 cars, will be equipped with air brakes as rapidly as possible, the cost of which, it is estimated, will reach $50,000,000.

The Edward P. Allis Company, of Milwaukee, Wis., report the following recent sales of "New Leyner" Drills: Three drills and compressor to Wm. Owsley & Company, of Butte, Montana; three drills and compressor to Gaddis Mining Company, of Oronogo, Mo.; two drills to Fayal Iron Company, of Eveleth, Minn.; two drills to Homestake Mining Company, of Lead, So. Dakota; one drill to Golden Reward Mining Company, of Deadwood, So. Dakota, and one drill to the United Verde Copper Company, of Jerome, Arizona. The Allis Company also report the sale of two water-jacketed blast furnaces to Guggenheim Sons for the Monterey, Mexico, plant. These furnaces are of 175 tons daily capacity, and are duplicate of an order for five which was filled by the Allis Company early last year. This company has also received a contract for a twenty-stamp cyanide plant for the Thayer M. & M. Company, of Miramar, Costa Rica, Central America. Several carloads of material for the three Wethey Multiple-Deck Roasting Furnaces, being built by this company for the Highland Boy Smelter of Salt Lake City, have gone forward. Each of these furnaces has four hearths, 10′×83′.

The outlook for trade in Mexico is particularly encouraging. The many improvements contemplated by the municipal authorities in some of the largest towns in the republic, the development of private undertakings involving the expenditure of large sums in the engineering line, and the construction of new roads would seem to indicate that the inquiries being received by merchants will shortly bring forth valuable contracts for material. Already orders have been received for a considerable quantity of pipe for water works in certain districts, and for small electric light plants. That American trade in Mexico is greatly interfering with the progress of British and German business there is no doubt. A report recently sent by an agent of a

German export firm to Hamburg says: "The only advantage that we can offer in this market, now, is the giving of long credits. In every other respect the United States has the advantage." A report to the British Foreign Office upon Mexican trade says: "The country is advancing rapidly in wealth and culture. Although the class of persons able and willing to pay for the best quality of goods is rapidly increasing, the cheaper articles are still, as a rule, the ones most suitable to the Mexican market. The United States and Germany are the competitors to be met on the field."

The prospect of an increase in direct trade with Sweden is bright, says Consul-General Winslow, at Stockholm: "A new railroad is to be constructed from Lulea, over the mountains, into Norway, thus making the territory near to the world's markets and giving it speedy communication with the seaports on the North Sea, which are never closed by ice; and it might be said that this land is virgin soil. Machinery will be needed, iron (manufactured) and steel rails required, tools to put in the mechanics' hands, etc. Great things are in store for Sweden during the coming years, and her wants are to be many and varied. Our merchants can find an outlet for almost any product that a new country is liable to require. A great mistake our exporters make is in not having the goods sent here properly packed and inspected before shipping. Many articles, such as machinery, bicycles, etc., lose their attractiveness and ready sale on account of their poor appearance on arrival. Belgium and England have been supplying Sweden with cast iron pipe, rails and iron and steel beams suitable for building purposes. In the city of Stockholm the old houses are fast disappearing, and the modern structures will require a great quantity of these beams. Sweden has to a great extent been overlooked by our merchants. In a great measure, the American goods come here through German and English houses, thus making the importations more expensive."

Purchases of many thousands of dollars worth of manufactured iron, hardware, naval stores, machinery and railway equipment already made for Cuba show the early development of trade possibilities following the establishment of stable government in the island. In the re-establishment of the sugar industry, alone, there will be great opportunities for American engineers, contractors and manufacturers. Prior to the war, 370 sugar estates were in operation. Of this number 110 sugar houses are said to have been destroyed during the insurrection. To repair each of these sugar houses would require from $30,000 to $50,000. All necessary repairs and installation of machinery destroyed would require an expenditure of more than $50,000,000. Naturally, this work of rehabilitating the sugar estates of Cuba will fall to Americans, and the machinery and other equipment necessary will be made by American firms. In addition, many of the buildings used by the factories that were destroyed were built of timber; these will no doubt be replaced by iron and steel structures. Then, as many of the large pieces of machinery have not been affected by the destruction of the buildings, the repairs will consist in many instances of minor pieces and the connection of pipes, etc. In the electrical line the field will be quite extensive among the sugar estates, as in the major part of them all electrical fittings were destroyed. Of the 1,000 miles of railway track on the island, the largest portion of it needs new rails and other material, and the rolling stock of all the roads, according to the best authorities, needs to be replenished with new equipment.

Industrial Notes.

A 90 horse-power Westinghouse gas engine has been installed in the works of H. K. Porter & Company, Pittsburg.

The order for iron pipe for the waterworks at Knoxville, Pa., has been awarded to R. D. Wood & Company, Philadelphia.

The contract for dredging the Christiana river, at Wilmington, Del., has been awarded to the New York Dredging Company.

New crushing machinery for the plant of the Lawrence Cement Company, Siegfried, Pa., is to be supplied by the Gates Iron Works, Chicago.

The gold medal for gas and gasoline engines exhibited at the Trans-Mississippi Exposition, Omaha, has been awarded to the Otto Gas Engine Works, Philadelphia.

The Jeanesville Iron Works Company, Jeanesville, Pa., have supplied a large sinking pump for the New Anchor mine, Cripple Creek, and a high-lift station pump for a Leadville mine.

A gold medal was awarded the Murray Iron Works Company, Burlington, Ia., at the Omaha Exposition, for its Sioux Corliss engine, which ran almost constantly during the exposition.

The Roessler & Hasslacher Chemical Company, New York, have been awarded a gold medal for their exhibit of cyanide of potassium and other chemicals, at the Trans-Mississippi Exposition.

The passenger elevators for the Central London Electric Railway will be supplied by the Sprague Electric Company, New York. There will be 48 elevators, each capable of carrying 120 passengers.

A contract for $50,000 worth of rope-making machinery is said to have been awarded by the government to The Watson Machine Company, Paterson, N. J. The machinery is for the navy yard at Boston.

The New York Filter Manufacturing Company, of New York City, has been awarded the contract for a mechanical filter plant of a capacity of 6,000,000 gallons, for the city of Norfolk, Va. The plant is to cost $55,000.

The Deane Steam Pump Company now occupy the new addition to their factory at Holyoke, Mass. It is 100 feet in length and gives a much-needed increase of room. A considerable quantity of new machinery has already been installed.

It is reported that the American Hoist and Derrick Company, St. Paul, Minn., and 26 Cortlandt Street, New York, have been awarded the contract for the 40-ton jib locomotive crane for the Port Royal Navy Yard. The company's bid was $39,500.

What are probably the largest machine tools ever shipped abroad are being delivered to an English concern by the Niles Tool Works Company, Hamilton, O. The order is for two heavy armor plate planing machines, the tables of the planers being 12×10×5 feet.

The Pittsburg Locomotive Works are busy on an order for fifty more of their consolidation locomotives, with 22 × 28 cylinders, for the Baltimore & Ohio Railroad. This is a large order, and the company will be obliged to continue day and night operation of its works for some time to come.

The Buffalo Forge Company, whose New York offices are at 26 Cortlandt Street, have captured the contract for supplying a 100 horse-power direct-connected high speed engine for the Morse Wool Treating Company, of Norton, Mass. The engine is to be used for electric lighting purposes.

The New York Filter Manufacturing Company have brought suit in the U. S. Circuit Court, Eastern District of Missouri, against Powell Jackson, trading as the Jackson Filter Company, of St. Louis, restraining him from manufacturing and selling the Jackson filter, alleging infringement.

The Riter-Conley Company, of Pittsburg, will furnish a steel tank for the Charlotte Oil Fertilizer Company, Charlotte, N. C., of a capacity of 20,000 bbls., and a tank for storing crude petroleum for the East India Company, of Amsterdam, Holland, the second order from the Holland company.

The contracts for the construction and equipment of the Paris underground electric railway have been awarded to the French branch of the General Electric Company. The third rail system will be used. The length of the line is to be 2½ miles, connecting the main lines of the Orleans railway.

W. H. Burtner, until recently vice-president of the American Tool Works Company, and B. B. Quillen, late secretary of the same company, have organized the Cincinnati Planer Company, and will occupy, about the first of January, the new and extensive quarters they have erected at Harrison avenue and Buck street, Cincinnati.

A duplicate of the Vulcan ice-making plant in use in Manila has been furnished to the government by the Vulcan Iron Works, San Francisco, for use in the Philippines. The Vulcan works are also supplying ice-making machinery for the steamer San Jose, of the Pacific mail steamship line, and for the Indian school at Fort Mohave.

The Berlin Iron Bridge Company, of East Berlin, Conn., have completed a bridge built for the town of Newport, N. Y. The structure is of the parabolic type, with steel floor beams and string-

ers, and has two spans, each about seventy feet long. The same concern is erecting a large fireproof blacksmith shop for the Waterbury Manufacturing Company, Waterbury, Conn.

The Brown Hoisting & Conveying Machine Company, 26 Cortlandt street, New York, will build a 200-foot gantry crane for the Pennsylvania Steel Company, at Steelton, Pa. The same company has been awarded a contract for coal and ore storage plants for the Bethlehem Iron Works. The plant for coal storage will have a capacity of 50,000 tons, while that for ore storage will have a capacity of 100,000 tons.

An order for 1,000 all steel hopper bottom cars has been placed with the Schoen Pressed Steel Company, Pittsburg, by the receivers of the Baltimore & Ohio Railroad Company, deliveries to be made early in the year. The Schoen concern has been forced to increase facilities because of this and other orders, and has planned to erect works sufficiently extensive to increase the output to 65 cars per day, and which will cost, equipped, about two million dollars.

The Elmira Manufacturing Company has been organized at Elmira, N. Y., to make hydraulic steam, and other engines and machinery. The officers are: President, I. D. Booth; vice-president, F. E. Doolittle; secretary, S. C. Estey; treasurer, S. J. Hall; general manager, N. A. Johns; attorney, Chas. M. Marvin. The directors are the aboved-named officers, together with Henry A. Moore, F. Bright, B. M. Masten, C. H. Firman, F. H. Rees, Wilbur Kenzie and J. N. Ward.

The Mesta Machine Company, of Pittsburg, formed by a consolidation of the Robinson-Rea Manufacturing Company, Pittsburg, and the Leechburg (Pa.) Foundry and Machine Company, have purchased a tract of land near Homestead, Pa., on which a plant costing $500,000 is to be erected. Rolling mill, steel works and tin-plate machinery, steel gears and steel castings will be manufactured. The company is officered as follows: President, George Mesta; secretary, J. O. Horning; treasurer, W. H. Rea; auditor, W. D. Rowan.

The Ramapo Iron Works, Hillburn, N. Y., and the Baldwin Locomotive Works, Philadelphia, are installing systems for the electrical transmission of power. For the former, Westinghouse, Church, Kerr & Company are supplying a 200 horse-power engine direct connected to a 120 kilowatt generator; and for the latter the same concern is furnishing a 300 horse-power engine direct connected to a 200 kilowatt generator. Westinghouse, Church, Kerr & Company are also installing eight automatic stoking machines in the plant of the A. & P. Roberts Company, Pencoyd, Pa., in addition to 30 similar machines already in operation in that plant.

The Pittsburg Terra Cotta Lumber Company, Pittsburg, Pa., have shipped from their No. 3 works, at East Palestine, O., 1,500 tons of fireproofing tile for fireproofing the power-house of the Dublin (Ireland) Tramway Power Company. Men were sent from this country to do the fireproofing work, and late advices from Dublin bring word that the tramway people are exceedingly well pleased with the work. Another order received by this company was for 1,000 tons of fireproof tile for a municipal building now in course of erection in the City of Mexico. The material has been made at the company's No. 2 works, at Port Murray, N. J., and has already been shipped to Mexico.

The Pittsburg Reduction Company, of Pittsburg, manufacturers of pure aluminum, with works at New Kensington, Pa., and Niagara Falls, N.Y., have received an order for aluminum for a new telegraph and telephone line to be erected in Manila, in the Philippine Islands. The order came through Saale & Company, of Yokohama, who are agents in Japan for the Pittsburg company, and calls for about twenty-five miles of telephone wire. The line will be built through the city of Manila proper, and will connect Cavite. The Pittsburg Reduction Company have also secured an order from the Standard Electric Company, of San Francisco, for 150 miles of wire, weighing 200,000 pounds, to be used in carrying electrical power from water falls in the Cascade Mountains to San Francisco.

Business is brisk at the plant of J. S. Mundy, Newark, N. J. Double-cylinder, double drum hoisting engines, with special boilers, to be mounted on a pile-driving car, have been ordered by the Missouri Pacific R. R. Company, and the Horseheads (N. Y.) Bridge Company has ordered a special bridge-erecting engine. A large order on which work is now progressing is for a 38,000-lb. hoisting engine for the Merritt-Chapman Derrick & Wrecking Company, to be placed on a combination lighter and wrecker. The engine is to have a capacity of 100 tons, and has two main hoisting drums, two auxiliary swinging drums, and four large extension winches. Only recently, a car-load of hoisting engines were shipped to Chicago by this firm, and a pile driving engine, derrick and hammer to Mexico.

Three Parsons steam turbines, of 500 horse-power each, are to be built by the Westinghouse Machine Company, East Pittsburg, Pa., for the

Westinghouse Air Brake Company, Wilmerding, Pa., to replace ordinary steam engines. Each turbine will drive a 300 kilowatt generator, furnishing current for electric lighting and for driving the Tesla motors used in the Air Brake Company's shops. The machine company is also building a 2,500 horse-power turbine for the United Electric Light & Power Co., of New York City, the first of an order of five of the same size. These will be the largest steam turbines ever constructed. They are to be installed in the new station at Twenty-eighth street and East River. Each turbine will be used to drive a 1,500 kilowatt multiphase generator. The five engines and generators, aggregating 12,500 horse-power, can be placed in about half the space now occupied by eight vertical Westinghouse engines of 1,200 horse-power each, each with Westinghouse generators, now in the Twenty-eighth street station.

The contract for the equipment of the underground trolley system for the Third Avenue Railroad Company, New York, has been awarded to the Westinghouse Electric and Manufacturing Company. The contract involves the expenditure of $5,000,000, and by its terms the Westinghouse company will construct the steam engines, boilers, and entire steam plant necessary to equip the power house, as well as the car equipment, electric generators and all the required electrical apparatus. The plans call for a power-house on the company's property at 216th Street, with a steam and electrical capacity of 64,000 horse power. The station will supply power for all the lines operated by the company, will be the largest of its kind in the world, and will have the most effective equipment for economizing fuel and labor. More than half the amount of the contract is for the steam plant, and the rest for the electrical apparatus. The latter will be manufactured at Pittsburg and at the works of the Walker Company, in Cleveland, O. The engines will be built at Pittsburg. The Westinghouse Company has also closed a contract with the Hanover Strassenbahn Aktien-Gesellschaft, a street railway company, of Hanover, Germany, for 101 large electric motors and 125 controllers for use in the cars of the road. The award of this contract is a remarkable victory for the Westinghouse company's products, the contract having been won in the face of the fiercest competition of German manufacturers.

An interesting decision in an infringement case has recently been made in the United States Circuit Court in the Eastern District of New York in regard to the well known Climax steam boiler, made by the Clonbrock Steam Boiler Works, of Brooklyn, N. Y. The Climax boiler is composed of a vertical shell surrounded by a peculiar arrangement of tiers of looped tubes, set obliquely to the axis of the central shell, the whole being set over an annular grate and enclosed in a cylindrical casing. This boiler has given excellent results in practice, and had been used with success by the Edison Electric Illuminating Company of Brooklyn, when the Columbian Steam Boiler Works, with which were connected former employees of the Clonbrock Company, began the construction of boilers practically identical with the Climax boiler, and one of these was built for, and accepted by, the Brooklyn Edison Company. The result was a suit for infringement, which has been decided in favor of the Clonbrock Company, the validity of the Morrin & Scott and the Morrin patents, under which the Climax boiler is made, being fully sustained. The defense set up was practically lack of novelty, and in support of this, there were offered as anticipatory inventions the Rogers & Black boiler, well-known in Philadelphia and elsewhere many years ago, and the Hazleton "Porcupine" boiler, composed of a central vertical shell with radial water tubes instead of the looped tubes of the Morrin patents. These and other inventions are fully considered in the opinion of the court in such a manner as to make the document very interesting reading in relation to this general type of boiler, and the result was a decision in which the Morrin patents were sustained in every point, the anticipations being denied and the infringement fully made out.

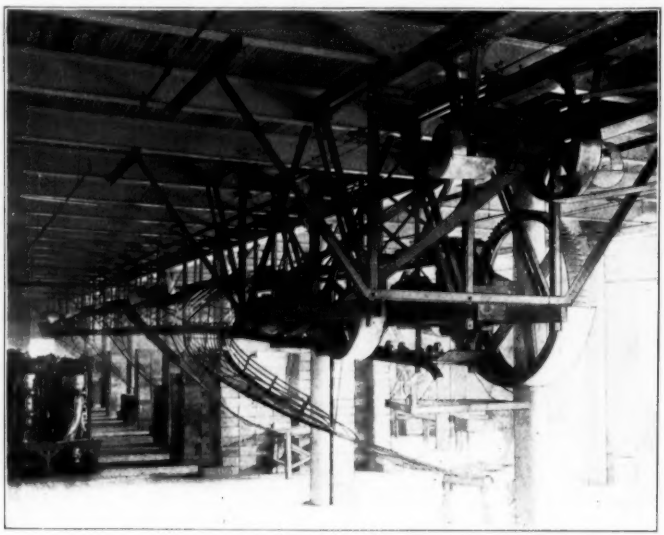
IMPROVED MACHINERY

NEW PROCESSES—NEW APPLIANCES

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Jeffrey Box Conveyer.

THE illustration herewith is a reproduction from a photograph of a light platform carrier, erected for the Ligget & Myers Tobacco Company, of St. Louis, Mo., some two years ago, and which has been in continuous service since that time. This labor-saving machine distributes the empty tobacco boxes to the different factories for packing, its daily delivery being 8,000 pieces. Its initial point is in the box factory, where the boys feed the boxes to it as they drop from the box-making machine. At a moderate speed they are carried to the different factories and delivered to the packing tables, this delivery being automatic and under the complete control of the foreman of the factory where the delivery is made. To accomplish this a special device had to be designed to meet the requirements.

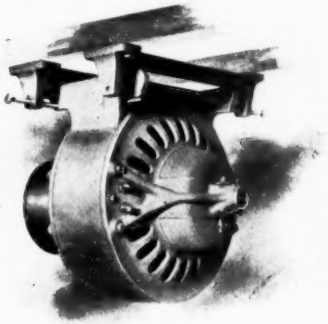


The construction of the carrier is a single strand of drop-forged steel chain, with steel plates forming the tables to carry the boxes riveted to it, these plates being provided with wrought gudgeons and wheels, which are bronze-bushed to reduce friction to a minimum. It is extremely smooth and noiseless in operation, and requires very little power to operate it, considering its extreme length, which is approximately 800 feet, by far the longest carrier of this type ever erected. The erection as well as construction is entirely of steel, being light, graceful, substantial and strictly fire-proof. The whole outfit was designed and built by the Jeffrey Manufacturing Company, of Columbus, Ohio. Many modifications of this type of carrier are possible, adaptable to any kind or weight of material, and to efficient delivery at almost any desired distance.

"Commercial" Iron-Clad Motor.

THE accompanying engraving is of the new commercial iron clad motor which has just been placed on the market by the Commercial Electric Company, Indianapolis, Ind.

As will be seen from the illustration, it is very compact and attractive in appearance, as well as thoroughly protected from mechanical injury, dust, and dirt, while the large lids which are placed in the casing above and below the commutator allow of easy access to the brushes. The novel method of mounting is admirably adapted to ceiling suspension, as well as for installation directly on the floor or foundation; and when suspended, as shown in the cut, the operation of the belt-tightening device is in no way interfered with or rendered less convenient than when mounted on the floor, since there are no bolts to be loosened. The machine, however, may be mounted on its own



support as with other ceiling machines. It is extremely convenient for direct belting to elevator machines when used in this way, and the manufacturers make a special reversible motor and controller for this purpose.

The magnet frame is of steel, with circular cores and pole shoes of the same material, thus affording a low resistance air-gap and the greatest possible efficiency of the magnetic circuit, while the end casings which carry the bearings are of cast-iron and are provided with ample ventilating holes. The workmanship and material throughout are of the highest class. The shafts are of steel, with self-oiling bearings and bronze linings, which are easily renewed.

Carbon brush-holders of simple construction and large capacity are used, and owing to the strong magnetic field, the sparking on change of load is avoided, so that the machines run for a long time with little attention. They are built in two standard speeds so that they are adapted to a large variety of users.

The Standard Time Stamp.

THE wider the realization of the truth of the aphorism, "Time is money," the more general becomes the use of the time stamp, which has already made itself invaluable in progressive manufacturing establishments. The Standard Time Stamp, an illustration of which is shown herewith, possesses special advantages in that it is a correct time-keeper, is absolutely automatic in setting dates, is solidly constructed and is entirely beyond the reach of tampering by unauthorized persons. The figures and letters on the wheels of the stamp train are engraved in solid metal. This secures a superior impression and the greatest possible durability.

For use in the shop, where labor is the basis of charging, and where it is highly important that a record of the exact time devoted to each job be kept, the Standard Time Stamp possesses the peculiar advantage of being the only time stamp making straight-line impressions. The fac simile of the impression made by the Standard, shown herewith, makes obvious the advantage of a straight-line record. The top and bottom lines can be changed in an instant, and the space left blank, or additional words, describing a peculiar transaction, can be brought into use by turning a knob.

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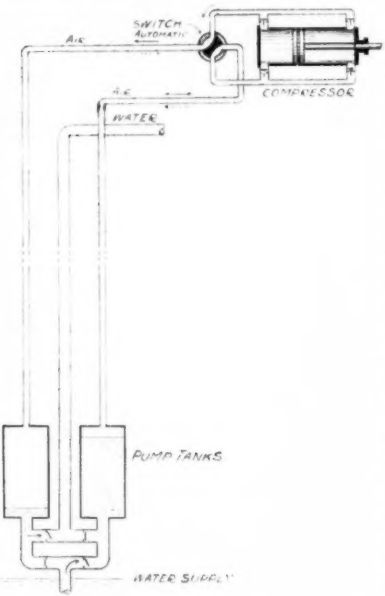
THE attention and investigaton of engineers and operators interested in the economical handling of water or of other liquids is asked for the Harris system of pumping by air pressure.

The system overcomes the difficulties encountered by many inventors in the use of compressed air for pumping purposes, by controlling the air absolutely in the engine room and by using it over and over again. The diagram shows clearly how these conditions are attained. With the compressor in operation and with the switch set as shown, the air will be drawn out of the right-hand tank and forced into the left-hand tank; and in so doing will draw water into the former and force it out of the latter. The charge of air in the system is so adjusted that when one



is emptied the other is just filled. At that moment the switch reverses the pipe conditions so that action in the tanks is reversed.

This switch, though a simple mechanism, is the subject of several patents. It is placed in the air pipes near the compressor, where the engineer can see its operation and adjust it as needed. It can be automatically operated in one of three ways: by means of the suction in the in-take pipe; by a mechanism that will throw the switch at some assigned number of strokes of the compressor; and by an electrically controlled mechanism, the circuit being made and broken by a pressure gauge on the in-take of the compressor, or by a float in one of the tanks. In every case the switch is made adjustable, and can be set or adjusted while the pump is in operation.

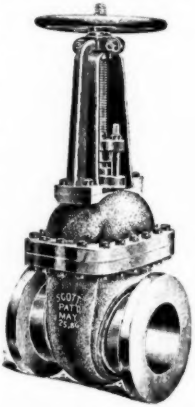
The system can be applied anywhere, but its peculiar advantages appear when the water is distant from the source of power, as in mines or wells, or where a power plant already installed desires to get water from some distant point or points.

The Pneumatic Engineering Company, 100 Broadway, New York, will send a free pamphlet describing the Harris system and explaining its adaptability to various uses.

High Pressure Valves.

THE accompanying illustration represents one of the extra high pressure Scott gate valves manufactured by the Roe Stephens Mfg. Co., Detroit, Mich. These valves are made for the highest steam working pressures, and were designed to fill a demand for a more durable and satisfactory article than is commonly used.

They are made to stand a high working pressure on steam, water, oil or gas mains, being tested to 1000 lbs. to the square inch. By the peculiar construction of their patent cylindrical wedge and full circular bearing upon the back of the disk, the wear is taken from the face and seat, thus insuring a perfect seating and the impossibility of the disks springing, bending or getting out of shape. The disks are raised by their lugs coming in contact with corresponding shoulders on the wedge. The lugs are so arranged that the bearings of one disk slightly rotate upon the other, so that the least movement on the stem releases one disk in advance of the other, making them easy to operate under the heaviest pressure. The seats in the iron body are screwed in, and are interchangeable. The discs are wedge-shaped, solid, or double-cylinder wedge, as desired. The stems in the iron body are made of the best steel, unless bronze is preferred. There is a ground joint under the end of the stuffing-box, so they can be packed when full open. Complete valve catalogues will be furnished by the manufacturers on request.



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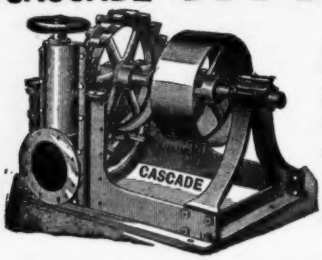

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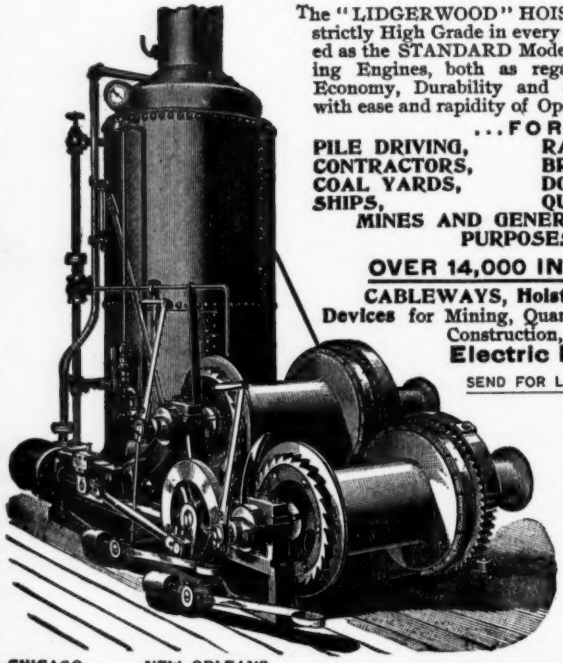

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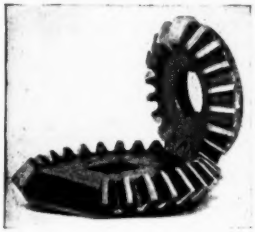

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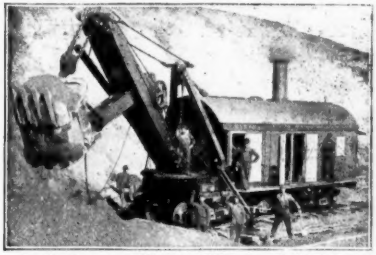

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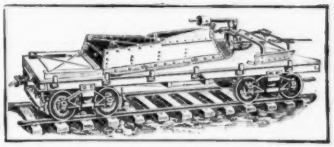

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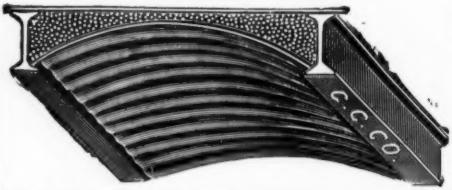

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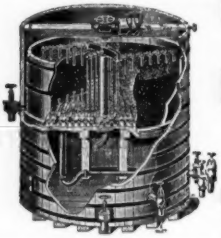

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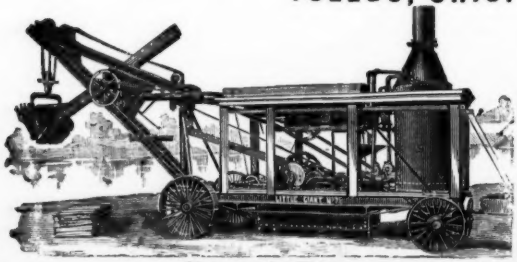

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THE ENGINEERING MAGAZINE.

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AUTHORS AND PAPERS FOR MARCH.

GEORGE WALLACE MELVILLE, U. S. N. (*Readings from Experience in Naval Engineering*)=Was born in New York in 1841 and attended the public schools of that city served an apprenticeship in the machine shop of James Binns, of Brooklyn; at the beginning of the civil war, entered the navy as third-assistant engineer; for his services on the Wachusett, in the capture of the Florida, he was detailed as chief-engineer of the latter; he was chief-engineer of the Tigress in the Polaris relief expedition; in 1879 he volunteered for the Jeannette expedition; he also volunteered for the Greely relief-expedition and contributed greatly toward its success; in 1886, he designed the machinery for the San Francisco and, a year later, was appointed engineer-in-chief of the navy, vice Loring, resigned. His service has practically covered the building of the present navy of the United States. He is an active or honorary member of numerous scientific societies, and president of the American Soc. of Mech. Engineers.

LOUIS J. MAGEE (*America and Germany as Export Competitors and Customers*)=Born in Malden, Mass., 1862; was graduated (A. B.) from Wesleyan University in 1885; entered the shops of the Thomson-Houston Electric Co. at Lynn and, after practical work there, erected several plants in the United States, and then spent a year and a half in Lima, Peru; in 1889 he took over the Thomson-Houston company's office in Hamburg; this led to the formation, in 1892 of the Union Elektricitäts Gesellschaft in Berlin, manufacturing on the basis of the experience of the General Electric Co. As one of the managing directors, Mr. Magee is identified with the German industry and his article in this number, written at the request of the Magazine, is prompted by a desire for a better understanding between the industrial nations.

CHARLES HUTTON CROUDACE, M. Inst. C. E. (*Railway Location and Surveys in Rajputana, India*)=Grandson of the late Charles Blacker Vignoles, F. R. S.; educated at Berlin, Queenwood College (Hampshire) and Carlsruhe Polytechnic College. He was employed on railways in Germany and Brazil for seven years, before accepting an appointment in the Public Works Department in India. He was engaged during 25 years in India on twenty irrigation and railway projects, surveys, and construction works. He was entrusted with the detailed surveys of the projected Karachi-Delhi (direct) railway, 550 miles in length. Since his return to England has reported on the Syrian-Ottoman Railway from Acre to Damascus and other railway projects.

H. F. L. ORCUTT (*Machine-Shop Management in Europe and America*)=Born in Ellsworth, Me., 1861; after graduation from the high school, in 1879, he entered the employment of F. H. Richards, the well-known mechanical expert; his intimate familiarity with American practice was gained with Mr. Richards and in the shops and drawing room of a leading machine-tool works of New England. He went to London for the Pratt & Whitney Co., and for two years acted as their expert on a special machine. For more than seven years his time has been divided between London and Berlin, in close touch with both the commercial and mechanical side of the vast business of Ludwig Loewe & Co. of whose English machine-tool business he has charge.

The recent erection of their enormous new works, for which he has been expert mechanical adviser, has been the means of renewing his touch with the latest practice on both sides of the Atlantic and of crystallizing his conclusions as to equipment, organization, and management.

AUTHORS AND PAPERS FOR MARCH.

JOHN RICHARDS (*The Development of Wood-Working Machinery*)=Born near Pittsburg, Pa , in 1834. After common and some special schooling was trained in iron and woodwork and in 1857 was appointed a foreman, and in 1864 superintendent of the Ohio Tool Co.'s Works at Columbus, Ohio. In 1868 went to Europe to investigate standard-gauge making. In 1870 founded the Atlantic Works (Richards, Thorne & Co.) at Philadelphia, and in 1876 Richards & Atkinson of Manchester, England, predecessors of Geo. Richards & Co., Limited, Broadheath. In 1878 established the American Standard Gauge Works at Philadelphia, and in 1881 the San Francisco Tool Co., at San Francisco. In 1888 began publication of the Magazine "Industry" of which he was editor eight years. In 1889 he was elected President of the Technical Society of the Pacific Coast and was re-elected for two successive terms.

Mr. Richards' writings on industrial subjects comprise three treatises on wood converting machines, and various papers, pamphlets, and essays on mechanical subjects His last work "A Manual of Machine Construction" was published in 1892. His original designs cover more than 1000 machines, among these special machines for the Royal Arsenal at St. Petersburg and the Elswick Works, Newcastle, England.

WM. R. WEBSTER (*Standard Specifications for Steel*)=Graduated from the Massachusetts Institute of Technology in the course of mining engineering and metallurgy in 1875; for several years after that was employed in connection with the manufacture of iron and steel, and the manufacture and erection of bridges; during this time he made an investigation of the relations between the chemical composition and physical properties of steel, for which work he was awarded, by the Franklin Institute, the John Scott Legacy Premium and Medal. Mr. Webster's present work is, and has been for several years, that of a consulting and inspecting engineer and general expert on iron and steel, with headquarters at Philadelphia, Pa.

HENRY McCOY NORRIS (*Machine-Tool Depreciation as an Element of Manufacturing Cost*)=Born in Trenton, N. J., 1868; was apprenticed to Bement, Miles & Co., Phila., Pa.; took special course in mechanical engineering at Sibley College, Cornell University; was draughtsman with the Phœnix Iron Co., Phœnixville, Pa., John A. Roebling & Son's Co., Trenton, N. J., the Brown & Sharpe Mfg. Co., Providence, R. I., and other concerns; designer with A. H. Reid, Philadelphia, Pa., and the Pond Machine-Tool Co., Plainfield, N. J.; supt. of the Appleton Mfg. Co., Phila., Pa., and the Riehlé Bros. Testing-Machine Co., Phila., Pa.; engineer with the Garvin Machine Co., New York, general manager of the Campbell & Zell Co., Baltimore, Md., and supt. engr. and manager of the Bickford Drill & Tool Co., Cincinnati, Ohio. Mr. Norris is a member of the American Society of Mechanical Engineers and other societies; he has written a large number of articles for the mechanical papers; he was first editor of the "Digest of Physical Tests," published by F. A. Riehlé, Phila., Pa.

EDWARD ALFRED HARMAN, M. Inst. C. E. (*The Field for the Automatic Gas Meter*)=Mr. Harman is the engineer and manager of the Huddersfield Corporation and is well known through his work in connection with their gas undertaking, and his contributions to the literature of the gas industry. He has in preparation for THE ENGINEERING MAGAZINE an important series of papers upon "The Mechanical Equipment of a Modern Gas Works."

WILLIAM HENRY HUNTER (*A Review of the Nicaragua Canal Scheme*)=Born June 16, 1849; educated at private schools and at the College of Physical Science (Newcastle-on-Tyne) attached to Durham University; after passing through the workshops, entered the office of the late Mr. Thomas Meik, M. Inst. C. E., then engineer to the River Wear Commissioners; passed thence to the office of Messrs. Meik & Nisbet, civil engineers, of Edinburgh and Sunderland; then became resident engineer on the works of the Hylton and Monkwearmouth Railway; in 1873 was appointed assistant engineer on the works for the reconstruction of the river Weaver navigation. At the inception of the Manchester ship-canal project, in 1882, joined the staff of Mr. (now Sir) Leader Williams, M. Inst. C. E., and on the formation of the canal company, was appointed chief assistant engineer, and in 1896, chief engineer.

Is a member of the *Comité Technique Adjoint au Conseil d'Administration de la Compagnie Nouvelle du Canal de Panama*, is a member of the Institution of Civil Engineers, and an honorary member of the Manchester Association of Engineers.

GEORGES DARY (*Electricity at the Paris Exposition of 1900*)=M. Dary is one of the best known writers for the French technical press. He has been, for some years, Secretary of the editorial board of *L'Electricien*, and has contributed frequently to the American papers.

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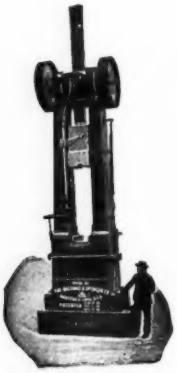

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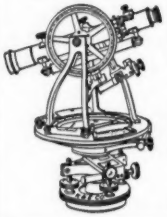

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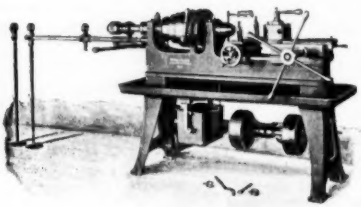

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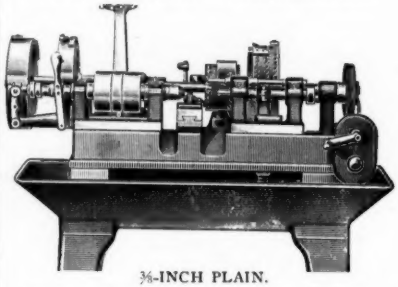

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A Buyers' Directory of

THE ENGINEERING TRADES.

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index on page 27.*

Acid Works Castings.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Advertising Experts.
Manufacturers' Advertising Bureau, 126 Liberty St., New York.

Air Brakes.
New York Air Brake Co., 66 Broadway, New York.
Westinghouse Air Brake Co., Pittsburg, Pa.

Air and Gas Compressors.
Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
Clayton Air-Compressor Wks., 26 Cortlandt St., N.Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo.

Anti-Friction Metals.
North American Metaline Co., 141-149 Third St., Long Island City, N. Y.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Arbor Presses.
Edwin E. Bartlett, Boston, Mass.

Architectural Iron.
Chester B. Albree, Allegheny, Pa.
Continental Iron Works, Brooklyn, N. Y.
Passaic Rolling Mill Co., Paterson, N. J.
Winslow Bros. Co , Chicago, Ill.

Architectural Sheet Metal Works.
Cincinnati Corrugating Co., Piqua, Ohio.

Automatic Machines.
Cleveland Machine Screw Co., Cleveland, Ohio.

Ballast Unloaders.
Marion Steam Shovel Co., Marion, Ohio.

Belting Conveyers.
Aultman Company, Canton, Ohio.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link Belt Engineering Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., 147 Cedar St., New York.

Belt Dressing.
Jos. Dixon Crucible Co , Jersey City, N. J.

Belting.
Aultman Company, Canton, Ohio.
Boston Belting Co., Boston, Mass.
Jeffrey Mfg Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Main Belting Co., Philadelphia, Pa.
Robins Conveying Belt Co., 147 Cedar St., New York.

Belt Lacing.
Bristol Co., Waterbury, Conn.

Bending Rolls.
Hilles & Jones Co , Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Bicycle Forgings.
J. H. Williams & Co., Brooklyn, N. Y.

Bicycle Frame Drilling Machines.
Stow Flexible Shaft Co., Philadelphia, Pa.

Blacksmiths' Tools.
Buffalo Forge Co., Buffalo, N. Y.
Hammacher, Schlemmer & Co., 209 Bowery, N. Y.

Blast Furnaces.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Blast Furnaces, Gas.
American Gas Furnace Co., Elizabeth, N. J.

Blowers.
American Blower Co., Detroit, Mich.
American Gas Furnace Co , 23 John St., New York.
Buffalo Forge Co , Buffalo, N. Y.
Gates Iron Works, Chicago, Ill.
Sprague Electric Co., 20 Broad St., New York.

Boilers.
Almy Water-Tube Boiler Co., Providence, R. I.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Gas Engine & Power Co., Morris Heights, New York City.
Gates Iron Works, Chicago, Ill.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Charles L. Seabury & Co., Morris Heights, New York City.
Star Drilling Machine Co., Akron, Ohio.
Stearns Manufacturing Co , Erie, Pa.
Taunton Locomotive Mfg. Co., Taunton, Mass.
Thorpe, Platt & Co., New York.
Robt. Wetherill & Co., Chester, Pa.

Boiler Fronts and Fittings.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

For Alphabetical Index to Advertisers, see page 27.

Boiler Compounds.
Dearborn Drug & Chemical Works, 29 Rialto, Chicago, Ill.

Boiler Inspectors.
Hartford S. B. I. & Ins. Co., Hartford, Conn.

Boiler-Makers' Tools.
Hammacher, Schlemmer & Co., 209 Bowery, N. Y
Hilles & Jones Co., Wilmington, Del.
Stow Flexible Shaft Co., Philadelphia, Pa.

Bolt Cutters.
Acme Machinery Co., Cleveland, Ohio.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Bolt and Rivet Headers.
Acme Machinery Co., Cleveland, Ohio.

Books.
Engineering Magazine Press, Ltd., 120-122 Liberty St., New York.

Boring Machines.
The Egan Co., 271-291 West Front St., Cincinnati, Ohio
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.
Wm. Sellers & Co. Inc., Philadelphia, Pa.

Box Makers' Machinery.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Brass Working Machine Tools.
Warner & Swasey, Cleveland, Ohio.

Brewery Supplies.
Fred. W. Wolf Co., 139 Rees St., Chicago, Ill.

Bricks.
Henry Maurer & Son, 420 E. 23d St., New York.

Brick and Tile Machinery.
F. D. Cummer & Son Co., Cleveland, Ohio.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Bridge Builders.
Passaic Rolling Mill Co., Paterson, N. J.

Bridge Railing.
Chester B. Albree, Allegheny, Pa.

Builders' Elevators.
American Hoist & Derrick Co , St. Paul, Minn.
John F. Byers Machine Co., Ravenna, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., New York.

Building Materials.
Chester B. Albree, Allegheny, Pa.
T. H. Brooks & Co., Cleveland, Ohio.
Cincinnati Corrugating Co., Piqua, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
H. W. Johns Mfg. Co., 100 William St., New York.
Henry Maurer & Son, 420 E. 23d St., New York.
Passaic Rolling Mill Co., Paterson, N. J.
Pittsburgh Terra Cotta Lumber Co., Pittsburg, Pa.
Winslow Bros. Co., Chicago, Ill.

Cable-Railway Driving-Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.

Cables, Electric and Submarine.
Okonite Co., Ltd., 253 Broadway, New York.

Cableways.
Fraser & Chalmers, Chicago, Ill.
Lidgerwood Mfg. Co., 96 Liberty St., New York.

Cables, Wire.
American Hoist & Derrick Co., St. Paul, Minn.
Cooper, Hewitt & Co , 17 Burling Slip, New York.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.
F. D. Cummer & Son Co., Cleveland, Ohio.

Cams and Tappets.
Chrome Steel Works Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Card Index Files.
Globe Company, Cincinnati, Ohio.

Car Shop Machinery.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Carriage and Wagon Machinery.
Buffalo Forge Co., Buffalo, N. Y.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.
Aultman Company, Canton, Ohio
Edw. P. Allis Co., Milwaukee, Wis.
Chrome Steel Works, Brooklyn, N. Y.
Stanley G. Flagg & Co., Philadelphia, Pa.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
McNeal Pipe & Foundry Co., Burlington, N. J.
Taunton Locomotive Mfg. Co., Taunton, Mass.
Walworth Manufacturing Co , Boston, Mass.
R. D. Wood & Co. Philadelphia, Pa.

Cement.
Atlas Cement Co., 143 Liberty St., New York.

Centrifugal Pumps.
Bucyrus Co., So. Milwaukee, Wis.

Centrifugals.
Henry G. Morris, Philadelphia, Pa.

Cesspool Cleaning Apparatus.
Odorless Excavating Co., Boston, Mass.

Chain Belting.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Chain Pipe Wrenches.
J. H. Williams & Co., Brooklyn, N. Y.

Chemical Works Machinery.
Atlantic Works, East Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Chemists, Manufacturing.
Roessler & Hasslacher Chemical Co., New York.

Chemists—Water and Oil.
Dearborn Drug & Chemical Works, 29 Rialto, Chicago, Ill.

Chloride of Lime.
Roessler & Hasslacher Chem. Co., 100 William St., New York.

Chucks.
Pratt Chuck Co., Frankfort, N. Y.

Clay-Working Machinery.
Aultman Company, Canton, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.

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Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.
Vulcan Iron Works, Toledo, Ohio.

Coal- and Ashes-Handling Machinery.
Aultman Company, Canton, Ohio.
C. W. Hunt Co., 45 Broadway, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Robins Conveying Belt Co , 147-149 Cedar St., New York.

Coal-Mining Machinery.
Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Arthur Koppel, 68 Broad St., New York.
John H. McGowan Co., Cincinnati, Ohio.
C. W. Hunt Co., 45 Broadway, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, New York.
Robins Conveying Belt Co., 147-149 Cedar St., New York.
Sullivan Machinery Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal-Washing Machinery.
Jeffrey Mfg. Co., Columbus, Ohio.

Cold Saws.
Q & C Company, Chicago, Ill.

Compressed Air Hoists and Motors.
Stow Flexible Shaft Co., Philadelphia, Pa.

Compressed-Air Shop Tools.
Clayton Air Compressor Works, 26 Cortlandt St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Concentrators and Pulverizers.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

Condensers.
Edw. P. Allis Co., Milwaukee, Wis.
Deane Steam Pump Co., Holyoke, Mass.
Wm. Baragwanath & Son, Chicago, Ills.
Fraser & Chalmers, Chicago, Ill.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Taunton Locomotive Mfg. Co., Taunton, Mass.

Consulting Engineers.
Blood & Hale, Boston, Mass.
A. B. Bowers, San Francisco, Cal.
Century Engineering Co., Cleveland, Ohio.
Madison Cooper, 410 No. First St., Minneapolis, Minn.
W. Dusedau, Brooklyn, N. Y.
Julian Kennedy, Pittsburg, Pa.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
Sydney F. Reynolds, Torry, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Wm. O. Webber, Boston, Mass.

Contractors.
A. B. Bowers, San Francisco, Cal.
Julian Kennedy, Pittsburg, Pa.

Contractors' Dump Cars, etc.
Gates Iron Works, Chicago, Ill.
Arthur Koppel, 68 Broad St., New York.

Contractors' Supplies.
American Hoist & Derrick Co., St. Paul, Minn.
John F. Byers Machine Co., Ravenna, Ohio.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Robins Conveying Belt Co., 147 Cedar St., New York.
Stearns Mfg. Co., Erie, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.

Converters.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Conveying Machinery.
Aultman Company, Canton, Ohio.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Engineering Co., Philadelphia, Pa.
Robins Conveying Belt Co., 147 Cedar St., New York.

Copper.
Canadian Copper Co., Cleveland, O.
Orford Copper Co., 37 Wall St., New York.

Corrugated Copper Tubes.
Taunton Locomotive Mfg. Co., Taunton, Mass.

Corrugated Iron.
Cincinnati Corrugating Co , Piqua, Ohio.

Cranes.
American Hoist & Derrick Co., St. Paul, Minn.
Brown Hoisting & Conveying Machine Co., Cleveland, Ohio.
Wm. Sellers & Co., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

Crushers—Ore, Phosphate, Rock.
Edw. P. Allis Co., Milwaukee, Wis.
Aultman Company, Canton, Ohio.
American Hoist & Derrick Co., St. Paul, Minn.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.

Cupolas.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Cyanide.
Roessler & Hasslacher Chemical Co., New York.

Cylinder Boring and Facing Machines.
Stow Flexible Shaft Co., Philadelphia, Pa.

Dating Stamps.
Standard Time Stamp Co., 844 Washington St., New York.

Diamond Drills.
American Well Works, Aurora, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 100 Broadway, New York.

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Dies and Die Forgings.
Walworth Manufacturing Co., Boston, Mass.

Die and Drill Steel.
Chrome Steel Works, Brooklyn, N. Y.
Hobson, Seaman & Co., 97 John St., New York.
Wm. Jessop & Sons, Ltd., 91 John St., New York.

Digesters.
Atlantic Works, East Boston, Mass.

Drawing Instruments and Materials.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co , New York.
Queen & Co., Inc., Philadelphia, Pa.

Dredging Machines.
Aultman Company, Canton, Ohio.
A. B. Bowers, San Francisco, Cal.
Bucyrus Co., So. Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Vulcan Iron Works, Toledo, Ohio.

Drills—Rock and Coal.
American Hoist & Derrick Co., St. Paul Minn.
M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 25 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 100 Broadway, New York.
Star Drilling Machine Co , Akron, Ohio.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.
W. F. & John Barnes Co., Rockford, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norton & Jones Machine Tool Works, Plainville, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Forging Plants.
Billings & Spencer Co., Hartford, Conn.

Drop Hammers.
Billings & Spencer Co., Hartford, Conn.
Long & Allstatter Co., Hamilton, Ohio.

Drying and Calcining Machines.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Dump Cars.
Goodwin Car Co., 96 Fifth Ave., New York.

Dynamos.
American Engine Co., Bound Brook, N. J.
C & C Electric Co., 143 Liberty St., New York.
Commercial Electric Co., Indianapolis, Ind.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Sprague Electric Co., 20 Broad St., New York.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg Co., Pittsburg, Pa.

Electrical Machinery and Supplies.
American Engine Co., Bound Brook, N. J.
Bristol Co., Waterbury, Conn.
C & C Electric Co., 143 Liberty St., New York.
Commercial Electric Co., Indianapolis, Ind
General Electric Co., New York.
Jeffrey Mfg. Co. Columbus, Ohio
Queen & Co., Inc., Philadelphia, Pa.
Wm. E. Quimby, 86 Liberty St., New York.
Sprague Electric Co., 20 Broad St., New York
B. F. Sturtevant Co., Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Weston Electrical Instrument Co., Newark, N. J

Electric Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter & Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Elevator Buckets.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia Pa.

Elevator Guards and Screens.
Harrington & King Perforating Co., Chicago, Ill.

Elevators.
Gates Iron Works, Chicago, Ill.
Morse, Williams & Co., Philadelphia, Pa.
Sprague Electric Co., 20 Broad St., New York.
Triumph Electric Co., Cincinnati, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Emery Wheels.
Carborundum Co., Niagara Falls, N. Y.

Emery-Wheel Machinery.
Stow Flexible Shaft Co., Philadelphia, Pa.

Engineers.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engineers' Wrenches.
J. H. Williams & Co., Brooklyn, N. Y.

Engineering Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., New York.
Queen & Co., Inc., Philadelphia, Pa.
Young & Sons, 43 South Seventh St., Philadelphia, Pa.

Engines, Blowing.
Edw. P. Allis Co., Milwaukee, Wis.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Fraser & Chalmers, Chicago, Ill.
Sprague Electric Co., 20 Broad St., New York.

Engines—Gas, Gasoline, and Petroleum.
American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Daimler Mfg. Co., Steinway, Long Island City, N. Y.
Struthers, Wells & Co., Warren, Pa.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo.
Westinghouse Machine Co., Pittsburg, Pa.

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Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Marine.
Atlantic Works, East Boston, Mass.
Gas Engine & Power Co., Morris Heights, New York City.
Marine Iron Works, Station A, Chicago, Ill.
Charles L. Seabury & Co., Morris Heights, New York City.

Engines, Stationary.
Edw. P. Allis Co., Milwaukee, Wis.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
John F. Byers Machine Co., Ravenna, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Bullock Mfg. Co., M C., Chicago, Ills.
Frick Company, Waynesboro, Pa.
Gates Iron Works, Chicago, Ill.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Slater Engine Co., Warren, Mass.
Star Drilling Machine Co., Akron, Ohio.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Vilter Manufacturing Co., Milwaukee, Wis.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Robert Wetherill & Co., Chester, Pa.

Engravers.
A. Mugford, 120 Liberty St., New York.

Excavators.
A. B. Bowers, San Francisco, Cal.
Aultman Company, Canton, Ohio.
Bucyrus Co., So. Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Robins Conveying Belt Co., 147-149 Cedar St., New York.
Vulcan Iron Works, Toledo, Ohio.

Fans, Cooling and Heating.
Sprague Electric Co., 20 Broad St., New York.

Fans, Ventilating.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Fraser & Chalmers, Chicago, Ill.
Sprague Electric Co., 20 Broad St., New York.
B. F. Sturtevant Co., Boston, Mass.

Feed-Water Heaters.
Edw. P. Allis Co., Milwaukee, Wis.
Broomell, Schmidt & Co., York, Pa.
Fraser & Chalmers, Chicago, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Taunton Locomotive Mfg. Co., Taunton, Mass.
Robt. Wetherill & Co., Chester, Pa.

Feed-Water Purifiers.
Fraser & Chalmers, Chicago, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.

Ferro-Silicon.
Carborundum Co., Niagara Falls, N. Y.

Fertilizer Machinery.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.

Files.
Nicholson File Co., Providence, R. I.

Filters.
New York Filter Mfg. Co., New York.

Fire Hydrants.
R. D. Wood & Co., Philadelphia, Pa.

Flexible Shafts.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.
T. H. Brooks & Co., Cleveland, Ohio.

Flour-Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.

Fly Wheels.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.

Forges.
Buffalo Forge Co., Buffalo, N. Y.

Forgings, Iron and Steel.
Chester B. Albree, Allegheny, Pa.
Billings & Spencer Co., Hartford, Conn.
Keystone Drop Forge Co., Philadelphia, Pa.
Strieby & Foote, Newark, N. J.
J. H. Williams & Co., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.

Forming Machines.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.

Friction Clutches.
Eastern Machinery Co., New Haven, Conn.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.
Reeves Pulley Co., Columbus, Indiana.

Furnace Builders.
Julian Kennedy, Pittsburg, Pa.

Furniture.
Globe Company, Cincinnati, Ohio.
Heber Wells, New York.

Furniture and Chair Machinery.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co. Cincinnati Ohio.

Gages—Pressure, Steam, Water, etc.
Bristol Co., Waterbury, Conn.
Walworth Manufacturing Co., Boston, Mass.

Gas Fixtures.
Walworth Manufacturing Co., Boston, Mass.

Gas Holders.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gas Machines and Generators.
American Gas Furnace Co., 23 John St., New York.
United Gas Improvement Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gas Plants.
American Gas Furnace Co., 23 John St., New York.
United Gas Improvement Co., Philadelphia, Pa.

Gas Producers.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

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Gas-Works Machinery.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gate Valves.
Jenkins Brothers, 71 John Street, New York.
Roe-Stephens Mfg. Co., Detroit, Mich.
Walworth Manufacturing Co., Boston, Mass.

Gear Cutters,
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Gearing.
Edw. P. Allis Co., Milwaukee, Wis.
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Morse, Williams & Co., Philadelphia, Pa.
New Process Rawhide Co., Syracuse, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.

Girders.
Chester B. Albree, Allegheny, Pa.
Berlin Iron Bridge Co., East Berlin, Conn.

Glass Polishing Machines.
Stow Flexible Shaft Co., Philadelphia, Pa.

Golf Club Heads.
J. H. Williams & Co., Brooklyn, N. Y.

Grain Elevator Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Robins Conveying Belt Co., 147-149 Cedar St., New York.

Grates.
Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.
Cleveland Twist Drill Co., Cleveland, Ohio.
Landis Tool Co., Waynesboro, Pa.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.

Grips, Cable Railways.
Robt. Wetherill & Co., Chester, Pa.

Hangers—See Pulleys.

Heating and Ventilating Apparatus.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Sprague Electric Co., 20 Broad St., New York.

Heaters, Steam and Hot Water.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., New York.
Walworth Manufacturing Co., Boston, Mass.

Helve Hammers.
Long & Allstatter Co., Hamilton, Ohio.

Hoisting Engines and Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
American Hoist & Derrick Co., St. Paul, Minn.
Aultman Company, Canton, Ohio.
Brown Hoisting & Conveying Machine Co., Cleveland, Ohio.
John F. Byers Machine Co., Ravenna, Ohio.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Fraser & Chalmers, Chicago Ill.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stearns Manufacturing Co., Erie, Pa.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo,
Webster, Camp & Lane Machine Co., Akron, Ohio.

Hollow Bricks.
Henry Maurer & Son, 420 East 23d St., New York.
Pittsburgh Terra Cotta Lumber Co., Pittsburg, Pa.

Hollow Chisel Mortisers,
The Egan Co., 271-291 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.

Hydrants.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Cement.
Atlas Cement Co., 143 Liberty St., New York.

Hydraulic Machinery.
John H. McGowan Co., Cincinnati, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

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Westinghouse Machine Co., Pittsburg, Pa.

Ice-Making Machinery.
Frick Company, Waynesboro, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Stillwell Bierce & Smith-Vaile Co., Dayton, Ohio.
Vilter Manufacturing Co., Milwaukee, Wis.

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Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Fred. W. Wolf Co., 139 Rees St., Chicago, Ill.

Incandescent Lamps.
Sawyer-Man Electric Co., New York.

Indexing Systems.
Globe Co., Cincinnati, Ohio.

Indicators, Steam-Engine.
Queen & Co., Inc., Philadelphia, Pa.

Industrial Railways.
C. W. Hunt Co., 45 Broadway, New York.
Arthur Koppel, 68 Broad St., New York.

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American Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.

Insulated Wire.
Okonite Co., Ltd., 253 Broadway, New York.

Insulating Varnish.
Sterling Varnish Co., Pittsburg, Pa.

Interior Conduits.
Sprague Electric Co., 20 Broad St., New York.

Iron.
Passaic Rolling Mill Co., Passaic, N. J.

Joists, Iron and Steel.
Chester B. Albree, Allegheny, Pa.
Passaic Rolling Mill Co., Paterson, N. J.

Kiers.
Atlantic Works, East Boston, Mass.

Kyanizing.
Otis Allen & Son, Lowell, Mass.

Lamps, Electric.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Lathes.
W. F. & John Barnes Co., Rockford, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Launches—Steam, Naphtha, etc.
Daimler Mfg. Co., Steinway, Long Island City, N.Y.
Gas Engine & Power Co., Morris Heights, New York City.
Marine Iron Works, Station A, Chicago, Ill.
Charles L. Seabury & Co., Morris Heights, New York City.

Link Belting.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
John F. Byers Machine Co., Ravenna, Ohio.
Pittsburg Locomotive Works, Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Stearns Manufacturing Co., Erie, Pa.

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Westinghouse Air Brake Co., Pittsburg, Pa.

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Bucyrus Co., So. Milwaukee, Wis.

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Jos. Dixon Crucible Co., Jersey City, N. J.

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Billings & Spencer Co., Hartford, Conn.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
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Hilles & Jones Co , Wilmington, Del.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Norton & Jones Machine Tool Works. Plainville, Conn.
Q & C Company, Chicago, Ill.
Wm. Sellers & Co., Philadelphia, Pa.
Stearns Manufacturing Co., Erie, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walworth Manufacturing Co., Boston, Mass.
Warner & Swasey, Cleveland, Ohio.
Worcester Machine Screw Co., Worcester, Mass.

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Marine Iron Works, Station A, Chicago, Ills.

Marine Machinery.
Gas Engine & Power Co., Morris Heights, New York City.
Lambert Hoisting Engine Co., Newark, N. J.
Marine Iron Works, Station A, Chicago, Ill.
Charles L. Seabury & Co., Morris Heights, New York City.

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Brandis Sons Co., Brooklyn, N. Y.,
Queen & Co., Inc., Philadelphia, Pa.

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Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

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Wm. Jessop & Sons, Ltd., 91 John St., New York.
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Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

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Cincinnati Corrugating Co., Piqua, Ohio.

Metal Punching and Shearing.
Harrington & King Perforating Co., Chicago, Ill.

Meters, Electric.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

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Bement, Miles & Co., Philadelphia, Pa.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Wm. Sellers & Co. Inc., Philadelphia, Pa.

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Gates Iron Works, Chicago, Ill.
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Arthur Koppel, 68 Broad St. New York.

Mining Machinery.
Edw. P. Allis Co., So. Milwaukee, Wis.
American Hoist & Derrick Co., St. Paul, Minn.
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Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
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Arthur Koppel, 68 Broad St., New York.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, New York.
Robins Conveying Belt Co., 147-149 Cedar St., New York.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Electric & Mfg Co., Pittsburg, Pa.

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Aultman Company, Canton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.
American Engine Co., Bound Brook, N. J.
C & C Electric Co., 143 Liberty St., New York.
Commercial Electric Co., Indianapolis, Ind.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Sprague Electric Co., 20 Broad St., New York.

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Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Naphtha Gas Machines.
American Gas Furnace Co , 23 John St., New York.

Nickel.
Canadian Copper Co., Cleveland, Ohio.
Orford Copper Co., 37 Wall St., New York.

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Walworth Manufacturing Co., Boston, Mass.

Oil-Gas Plants.
American Gas Furnace Co., 23 John St., New York.

Oil Separators.
Harrison Safety Boiler Works, Philadelphia, Pa.

Open Links.
Keystone Drop Forge Co., Philadelphia, Pa.

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J. H. Williams & Co., Brooklyn, N. Y.

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Fraser & Chalmers, Chicago, Ill.

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F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

Ornamental Iron Work.
Chester B. Albree, Allegheny, Pa.
Winslow Bros. Co., Chicago, Ill.

Packing.
Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., New York.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., 16 Warren St., New York.

Paddle-Wheel Machinery.
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Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.

Paints for Iron and Steel.
W. W. Lawrence & Co., Pittsburg, Pa.

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Jeffrey Mfg. Co., Columbus, Ohio.
Robins Conveying Belt Co , 147-149 Cedar St., New York.
Robt. Wetherill & Co., Chester, Pa.

Pattern-Makers' Machinery.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Penstocks.
Atlantic Works, East Boston, Mass.

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Roessler & Hasslacher Chemical Co., New York.

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Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.

Pile Drivers.
Bucyrus Co., So. Milwaukee, Wis.

Pipe, Cast Iron.
Jeanesville Iron Works, Jeanesville, Pa.
McNeal Pipe & Foundry Co , Burlington, N. J.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coverings.
Michigan Pipe Co., Bay City, Mich.

Pipe-Cutting and -Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ills.
Walworth Manufacturing Co., Boston, Mass.

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Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.
Walworth Manufacturing Co., Boston, Mass.

Pipe, Wrought-Iron.
Walworth Manufacturing Co., Boston, Mass.

Placer Mining Machinery.
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Planers.
Bement, Miles & Co., Philadelphia, Pa.
Hilles & Jones Co., Wilmington, Del.
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J. A. Fay & Co., Cincinnati, Ohio.

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Atlas Cement Co., 143 Liberty St., New York.

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Wm. Sellers & Co , Inc., Philadelphia, Pa.

Power Punches and Shears.
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Wm Sellers & Co., Inc., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Power-Transmission Machinery.
Aultman Company, Canton, Ohio.
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Sprague Electric Co., 20 Broad St., New York.
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Preservation of Lumber.
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Presses, Hydraulic, etc.
Ferracute Machine Co., Bridgeton, N. J.
Niles Tool Works, Hamilton, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Printers Supplies.
Heber Wells, New York.

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Propeller Wheels.
Marine Iron Works, Station A, Chicago, Ills.

Prospecting Drills.
American Well Works, Aurora, Ill.
Star Drilling Machine Co., Akron, Ohio.
Sullivan Machinery Co., Chicago, Ill.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
Aultman Company, Canton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Reeves Pulley Co., Columbus, Indiana.
Robins Conveying Belt Co., 147-149 Cedar St., New York.
Saginaw Mfg. Co., Saginaw, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
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Fraser & Chalmers, Chicago, Ill.

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Edw. P. Allis Co., Milwaukee, Wis.
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Barr Pumping Engine Co., Philadelphia, Pa.
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Guild & Garrison, Brooklyn, N. Y.
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Wm. E. Quimby, 86 Liberty St., New York.
Snow Steam Pump Works, Buffalo, N. Y.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co,. Philadelphia, Pa.

Punching and Shearing Machinery.
Bement, Miles & Co., Philadelphia, Pa.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
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John H. McGowan Co., Cincinnati, Ohio.
Rand Drill Co., 100 Broadway, New York.
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Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens.
Harrington & King Perforating Co., Chicago, Ill.

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H. B Smith Co., 137 Center St., New York.

Railroad Ditchers.
Jeffrey Mfg. Co., Cleveland, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
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Westinghouse Air Brake Co., Pittsburg, Pa.

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Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
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Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson & Stillman Co., 210 E. 43d St., New York.

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H. K. Porter & Co., Pittsburg, Pa.
Westinghouse Air Brake Co., Pittsburg, Pa.

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Rawhide Pinions.
New Process Rawhide Co., Syracuse, N. Y.

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Waters Governor Co., 34 Oliver St., Boston, Mass.

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Frick Company, Waynesboro, Pa.
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Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Robins Conveying Belt Co., 147-149 Cedar St., New York.

Rock Drills.
American Hoist & Derrick Co., St. Paul, Minn.
M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Works, 26 Cortlandt St., New York.
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Rand Drill Co., 100 Broadway, New York.

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Passaic Rolling Mill Co., Paterson, N. J.

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Passaic Rolling Mill Co., Paterson, N. J.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Rope Transmission.
Aultman Company, Canton, Ohio.
C. W. Hunt Co., 45 Broadway, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Rubber Goods.
Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., New York.

Saw-Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
The Egan Co., 271-291 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St, Cincinnati, Ohio.
Jeffrey Manufacturing Co., Columbus, Ohio.

Schools.
International Correspondence Schools, Scranton, Pa.
Michigan College of Mines, Houghton, Mich.

Screens, Mining.
Aultman Company, Canton, Ohio.
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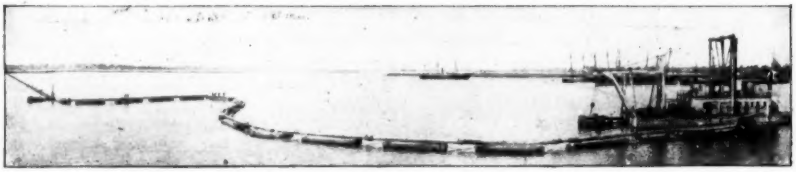

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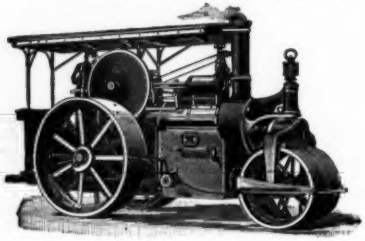

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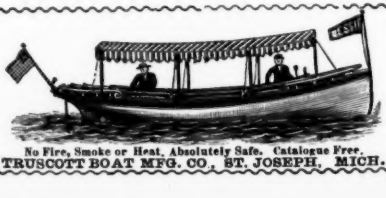

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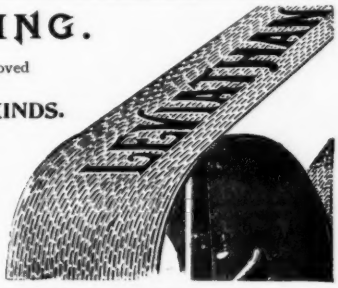

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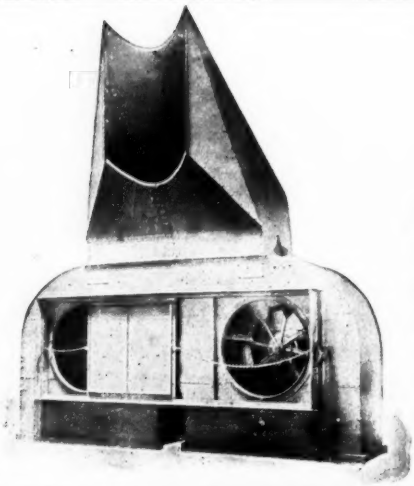

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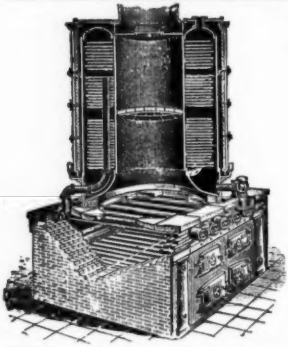

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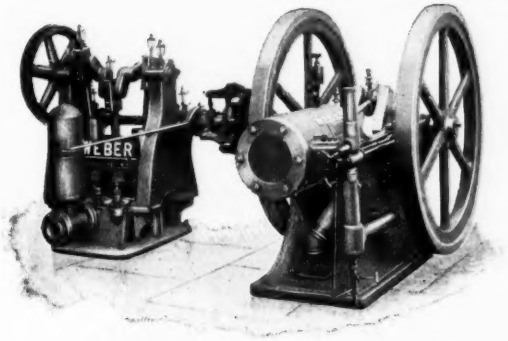
by a cast iron spider, and thoroughly insulated with mica and micanite.

The design of this machine is such that a very small amount of energy is dissipated at the brushes. The spider construction allows perfect ventilation on all sides, and consequently a cool commutator.

Reaction brushes of fibre graphite are used. No shifting of brushes is required from no load to full load, and sparkless operation is maintained. The engine is cast in a single piece, is very compact, and all wearing parts arranged for adjustment. The engine cylinder is lagged, reliable oil devices are provided for all bearings, and a delicate regulator, by its operation, maintains a practically constant speed.

The valve of the engine is of the piston type, and therefore practically balanced. The crank discs are counterbalanced, and high speed is made possible. The governor wheel and the armature serve to assist materially in resisting any sudden variation of speed.



WEBER GAS ENGINE DIRECT CONNECTED TO TRIPLEX PUMP.

This set is one of a line of generating sets, designed and built by the B. F. Sturtevant Co., of Boston, Mass. The smallest sets have a 4×4 engine, with an output of 3000 watts, and a combined weight with the generator, of 1,100 lbs. The largest size is 7×7 engine, with an output of 10,000 watts, and a combined weight of 2,700 lbs. These engines are designed to operate at 90 lbs. pressure. There is also made a line of sizes suitable for operation at very low pressure.

It is evident that this construction makes possible a minimum weight for a given output.

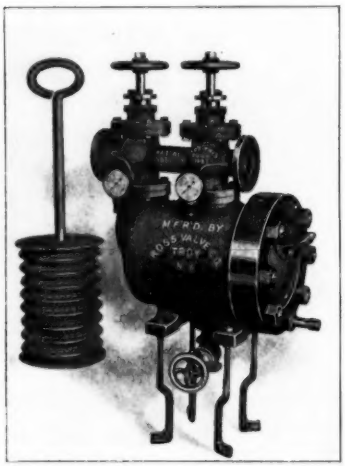
The Weber Gas Engine.

THE economy and convenience of the gas engine are so apparent that its failure to force itself into vastly wider use is one of those conditions difficult of satisfactory explanation. It is evident that there is a demand for a simple and reliable engine that would be more economical, safer, cleaner, and occupy less floor space than the steam engine, with its coal and ash heaps, water service, its long, tedious and costly waits while raising steam an hour or so before actually needing the power generated, with all the attending vexations and dangers of fire and explosion; in fact a motor that can be used anwhere, by anyone, for any purpose, which would not require attention while in operation, either as regards supplying the fuel, or regulating the amount of power and speed. This demand is supplied by the engine operated on gasoline, town gas, natural gas, kerosene, crude oil, distillate, or producer gas.

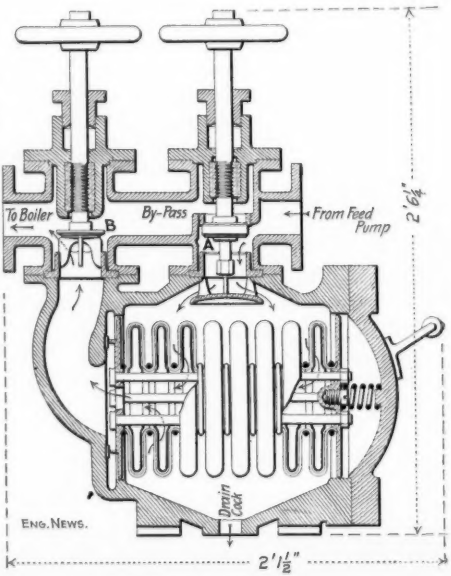
The half-tone illustration here shown is from a photograph of a 10 h. p. Weber gas engine direct connected to a 5 × 8 triplex pump suitable for mine or mill service. The manufacturers, however, the Weber Gas and Gasoline Engine Co., 428 South West Boulevard, Kansas City, Mo., make engines of a great number of sizes for all power purposes. Among the most notable of the applications of the gas engine are to hoisting engines for mines, docks, and quarries, pumping plants for railroads, mines, and mills; to compressing plants for mines and other industrial purposes. They also build special combinations, such as combined engines and blowers for ventilation, combined engines and dynamos, and combined engines and special haulage machines for mining. Mention might be made of the fact that this mining equipment can be safely operated underground, at a considerable saving over the compressed air system for hoisting, pumping, etc., underground. The Weber company will be very glad to furnish full information and handsomely illustrated catalogues in English or Spanish to interested parties.

A Filter for Removing Oil From Feed Water.

A VERY essential part of the equipment of a surface-condensing steam engine plant, especially in marine service, where fresh feed water is not readily available, is some means of removing from the water of condensation, which is to be used over again as feed water, the lubricating oil which has been carried out of the cylinders by the exhaust steam. In surface condensing the same water is used over and over again, but the oil, being fed to the cylinders continuously, gradually accumulates in the feed water, and enters the boiler, where it may become a source of danger. A thin film of oil on the heating surface preventing the water from adhering to it, may cause a plate or a tube to be overheated, and possibly cracked, and this danger is greater if the oil makes a thick paste with any mud or fine scale that may happen to be present in the boiler. The apparatus for removing oil from feed water, shown in the accompanying section, was put on the market a few years ago in England by Messrs. Railton & Campbell, and largely introduced by them in ocean-going steamers. It is now being made in this country by the Ross Valve Co., of Troy, N. Y. The filter is placed between the feed pumps and the boiler, and consists essentially of a chamber containing a bag made of the fabric known as "Turkish towelling," so folded as to obtain a large area of filtering surface in a small space. The surface of the bag is formed into a series of deep circular corrugations by being drawn over a bronze skeleton shown in Fig. 1, and drawn down between each of the sections by means of strings wound around it. The area of the filtering surface is made from 250 to 1,000 times the area of the feed pipe, according to the service required. The threads of the Turkish towelling retain the oil until they become saturated with it, while they let the water pass through. The filter is so constructed that the water passes from the outer side of the bag through it and the metal skeleton to the interior of the latter, and thence to the outflow pipe, as shown. The oil gradually clogs up the filtering material, increasing the resistance to the passage of the water. This resistance is indicated by the difference in the readings of the two pressure gages, one on the inlet and one on the outlet side of the filter. When the difference in pressure reaches 2 or 3 lbs. per sq. in. the filter may be cleaned by reversing the direction of the current, allowing the wash water to run to waste, or by changing the filter bag, a fresh one always being kept in reserve. The head of the filter chamber may be opened, the filter bags changed, the skeleton and the bag being removed and it and the head replaced inside of five minutes. The washing of the filter by reversing the current of water is done by operating the valves in the following manner: The inlet valve, A, is first screwed down and closed; B is then closed, and the drain cock



FEED-WATER FILTER. FIG. 1.



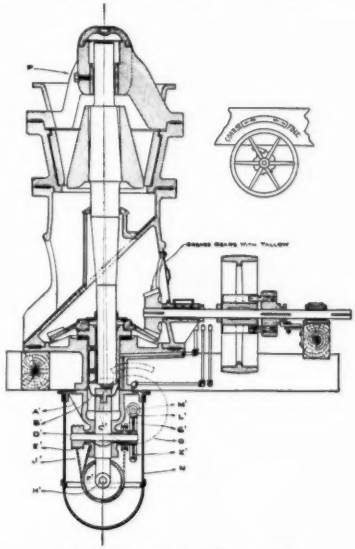
FEED-WATER FILTER. FIG. 2.

opened. Valve A is then opened a little and the current of water thus created washes the outside of the filter. A is then closed and B opened, causing water to pass from the boiler through the filter bag from the inside. The valve, A, is ingeniously made to perform the double function of a stop-valve and a by-pass valve, as will be seen.

Adjustable "Comet" Crusher.

THE section shown herewith is of the Fraser & Chalmers adjustable "Comet" crusher, whose operation is as follows:

Turning the hand wheel from left to right will raise the spindle and crush fine; turning the hand

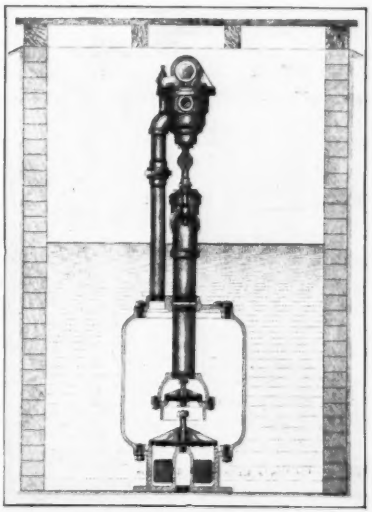


ADJUSTABLE "COMET" CRUSHER.

wheel from right to left will lower the spindle and crush coarse. Ratchet and pawl are provided immediately behind the wheel, and prevent the hand wheel from moving on account of jar. Two sheaves are mounted on the end of a vertical moving ram to carry chain for raising and lowering the ram. This ram has a slot so as to allow the worm-wheel shaft to work freely through it. At the upper end of the ram is a brass cup-shaped bowl which is filled with oil, providing a lubricant. This cup moves up and down, carrying the oil with it. On the end of the ram are the ordinary button and toe on which the spindle rests. In lowering the ram the spindle follows it in passing through the driving bevel gear, its upper end passing through the oscillating box in the tripod. Not only is this crusher thoroughly adjustable to produce varying product, but it will also accommodate a large amount of wear when the same size product is required. The mechanism for raising and lowering the spindle is so constructed that it is not necessary to stop the crusher to make the adjustment. By making the upper bearing a fixture, the position of bevel wheel hub also being a fixture, the distance between these two bearings remains the same, and the spindle sliding through them maintains its angle irrespective of the various positions in its height. Manufactured by Fraser & Chalmers, Chicago, Ills.

Merrill Pneumatic Pump.

THE type of pneumatic pump shown in the accompanying engraving embodies recent improvements upon the construction formerly brought out by Mr. F. H. Merrill, consisting mainly in the entire elimination of floats, the removal of valve-actuating mechanism from the water chambers, and the placing of a self-contained air-valve above the water level, thereby avoiding the difficulties heretofore experienced. In the section shown herewith there may be seen the water admission and discharge valves, and the absence of any other moving part below the water will be noted. The automatic air valve consists of a main air valve, controlled by an auxiliary valve, both being driven by differential pistons, on which the air pressure is applied. The movement of the air valve is predetermined, and adjusted to the maximum filling capacity of the



MERRILL PNEUMATIC PUMP.

water chamber, which is so proportioned as to exceed the discharge capacity, thereby insuring complete filling of the chamber.

Pliable cup packings, held out by brass tension rings are used on the piston valves to prevent leaking. These cup packings, working in composition cylinder linings, are subject only to the

MERRILL PNEUMATIC PUMP. DUPLEX TYPE.

action of compressed air, from which sufficient lubrication is obtained by the oil taken up during the compression of the air.

In practice it has been found that these cup packings are exceedingly durable, wearing for several years and remaining pressure tight, and, being accessible, they are easily and cheaply renewed if necessary.

The automatic air valve may be placed just above the water level, or any distance away from the water chambers, but it is preferable to place the air valve near the water level in order to avoid the loss of air required to fill the connecting air pipes above. When the water chamber is nominally submerged the velocity of inflow will carry the water in the air-pipe some distance above the water level, and to a still greater height by an increased submergence, and usually it is sufficient to reduce the clearance loss very materially.

The water chambers are now made in various forms and sizes as required to conform to the existing conditions of source from which water is to be taken.

For moderate service up to 50 gal. per minute the single acting type is adapted, but for heavier service a duplex type is constructed.

The pumps are simple in their construction, and are guaranteed to work as represented, and to give satisfaction. They are sold to be operated by any make of air compressor, and can be set up without trouble by any plumber or mechanic.

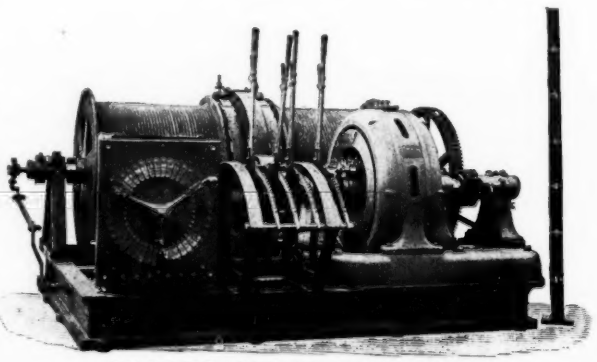
For taking water from several sources, with a single power plant, or from a distant point by the use of any existing power, regardless of distance, this pump is particularly adapted.

The Merrill Pneumatic Pump Co., 143 Broadway, New York, will forward descriptive circular and furnish all desired information upon request, and will also quote price upon receipt of full particulars regarding conditions.

Double Drum Hoist and Electric Motor.

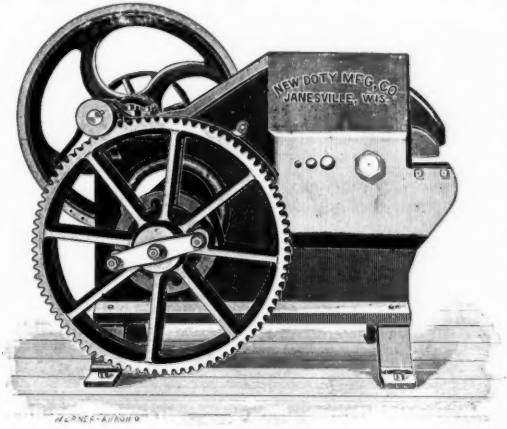
THE electric hoist illustrated herewith shows one of the recent applications of a General Electric induction motor to a double independent drum Lidgerwood mine hoist. It is compact in form, and the levers controlling the clutches and brakes and handle of rheostat are placed in the position most convenient for control by the operator standing on a platform above the floor and having a clear view over the top of the hoist.

Each friction drum is driven through a single



DOUBLE DRUM HOIST AND ELECTRIC MOTOR.

reduction gearing by a 100-volt 12-pole induction motor of 30 h. p. capacity, running at 600 revolutions per minute. Each drum is independent, and is 42 inches in diameter by 40-inch face. Together, they hold about 420 feet of ⅞-inch rope. The maximum hoisting speed is 320 feet per minute, and the weight hoisted, *i. e.*, load, car and cage, 2,100 lbs. The depth from which the load is to be hoisted 400 feet from the surface.



NEW DOTY SHEAR.

"New Doty" Shear.

We give herewith a very good illustration of a shear manufactured by the New Doty Manufacturing Co., of Janesville, Wis. It is made in six regular sizes, in all of which the knives for flat or round iron are independent of each other, and both sets of knives are at all times ready for use. The round iron knives are made the reverse of the iron, and, therefore, do not flatten it in cutting. The eccentric is so designed as to allow a short stop after each stroke, in order that the work may be adjusted for the next stroke, thus permitting the operator to take advantage of the next stroke. The machines are adapted to be run at 25 or more strokes per minute, the speed being governed by the ability of the operator to handle the material.

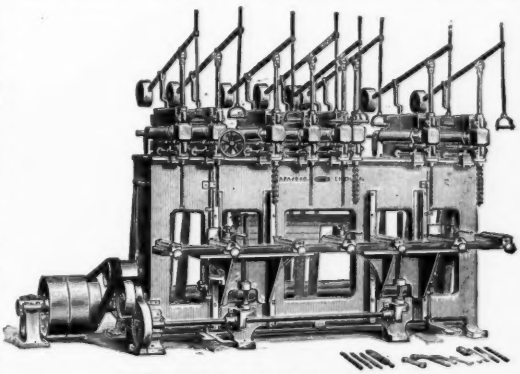
The shear shown in the illustration will cut ⅝ by 5 inch flat iron.

Eight-Spindle Vertical Car-Boring Machine.

The makers claim for the large, eight-spindle vertical car-boring machine, illustrated and described herewith, superior advantages over any other boring machine designed for use in railway car construction or wherever several holes are desired to be bored in a timber simultaneously. The capacity of the machine by the automatic and simultaneous action of the augers is increased to about three times the usual speed of production, and the boring is sufficiently accurate to dispense with reversing a piece, when the holes are to correspond on both sides.

The machine is of very massive construction, consisting of a heavy frame, supporting eight boring spindles and their carriages, and an automatically adjusting table. All the joints are accurately planed and fitted, and the metal distributed to insure the requisite stiffness and durability.

The boring spindles are eight in number, made of steel, and are separately adjustable, either across the machine or vertically, the transverse adjustments being made by screw and handwheel, and the vertical adjustment being produced by the movement of a counter balanced lever with handle attached. The transverse movement of the spindles is 14″, and the vertical motion is sufficient to bore through 14″ material. Stop collars are fitted to each spindle for gauging the depth of bore when boring by hand, and for holding them securely to the required position when raising the



EIGHT-SPINDLE CAR-BORING MACHINE.

material to the boring bits by means of the power elevating table. The machine can be furnished with a lesser or greater number of boring spindles. The spindle carriages are moved along the top of the frame independently, by a hand-wheel and pinion, operating on a rack that extends the entire length of the machine, and have clamps for holding them firmly to their several positions.

The table is very heavy for supporting large timbers, and is raised and lowered on two large, square thread screws that are operated by an improved friction device, having provision for taking up the wear. This elevating mechanism is controlled by means of compound treadles, a pair at each end of the framer. Stops are provided for regulating the depth of bore, the lower one automatically stopping the table movement. Four friction rolls in the table assist in the ready manipulation of the material, which is held firmly in position by means of eccentric lever clamps It will receive a timber 14″ square.

With the outside boring spindles at their extreme limit, two holes may be bored 10′ from centre to centre, eight holes may be bored from 4½″ to 17″ apart. Any two spindles may be brought close enough together to bore 4½″ from centre to centre. Each spindle is driven by a separate belt from a drum countershaft attached to the base of the frame.

The builders of this machine, J. A. Fay & Co., 271 to 291 West Front Street, Cincinnati, Ohio, have had a special corps of expert draughtsmen and mechanics at work for the past year, designing and perfecting new and improved wood-working machines, and this is one of those that they have just brought out.

This company make a full and complete line of high grade machines for manufacturing articles of every description out of wood, and they can furnish single machines or complete outfits for any kind of plant with their make of machinery, and they will be pleased to give full information and quote special prices on this or any other improved wood-working machinery.

Bristol's Steel Belt Lacing.

It is now nearly ten years since the Bristol Co., Waterbury, Conn., began manufacturing their steel belt lacing which has become within that time familiarly known and very widely used at home and abroad. There are over one hundred different sizes and lengths adapted to different styles and widths of belting. The illustrations Figs. 1, 2, and 3, show the three different types that are made, of which Fig. 1 represents that originally placed upon the market and designed particularly for leather belts.

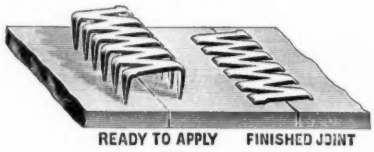


FIG. 1.

The type illustrated in Fig. 2 was brought out later, to meet the demand for a fastener for woven belts such as are made of cotton and rubber. In this style the distance between the rows of spurs is greater than in the original form shown in Fig. 1, and thus affords a better hold on ends of a belt of a woven or fibrous nature. Both types of the lacing shown in Figs. 1 and 2 have the distinctive and patented feature of being formed from blanks

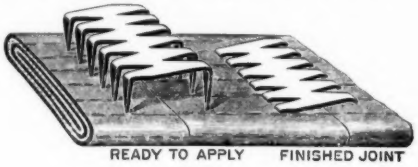


FIG. 2.

of a zig-zag shape, the shape being such that the blanks may be successfully cut from a ribbon of steel without waste of material.

The latest design shown in Fig. 3, which is now being introduced, combines the special features of both of the previously-described types, the essential difference being that there are two rows of spurs on each side of the centre instead of one.

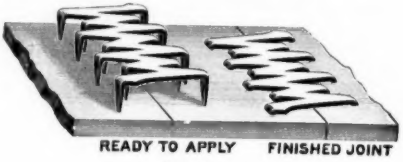
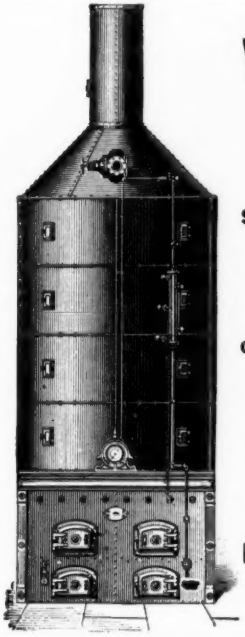


FIG. 3.

The advantages of this new form of lacing are that it is equally applicable to leather, cotton, or rubber belts, and that the double rows of spurs on each side of the joint insure great strength, especially when applied to old and worn belts. All the above types have been carefully designed to give a maximum of strength with a minimum amount of material. All three styles are easily applied without the use of special tools, making smooth and elastic joints. Samples will be mailed free on application to the makers.



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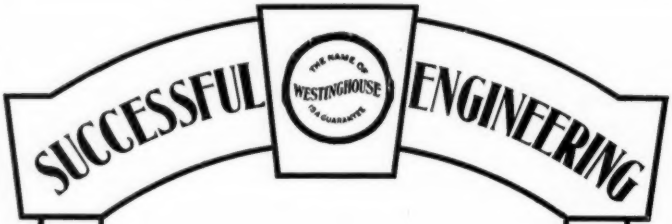

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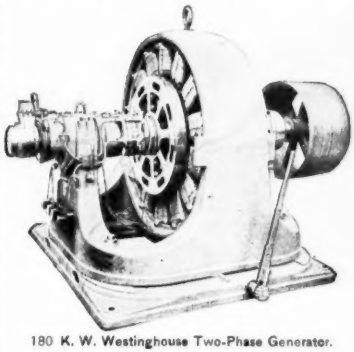

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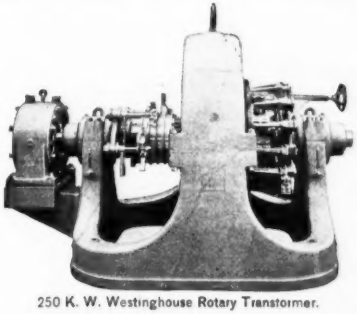

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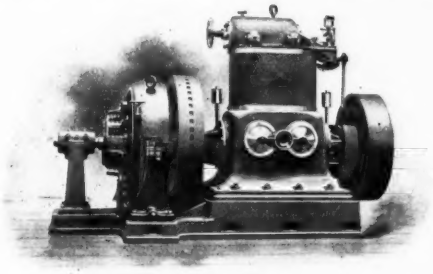

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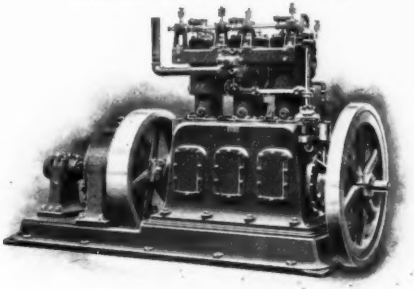

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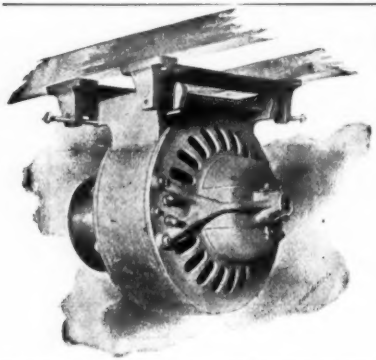

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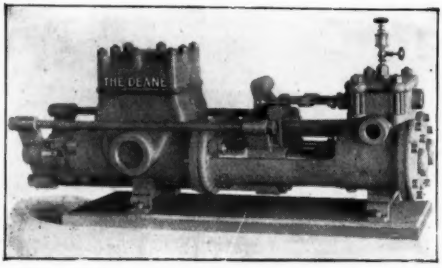

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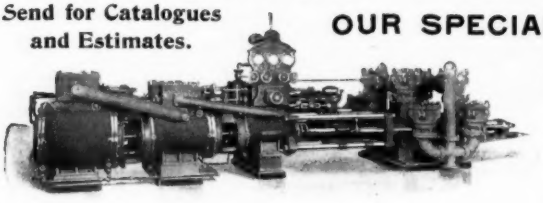

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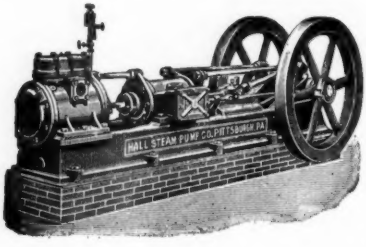

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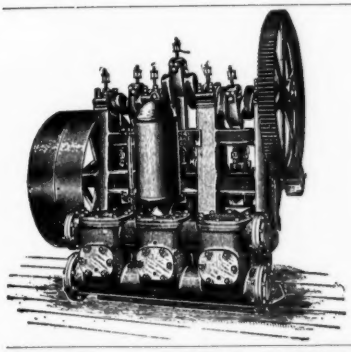

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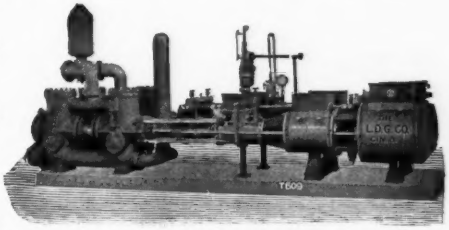

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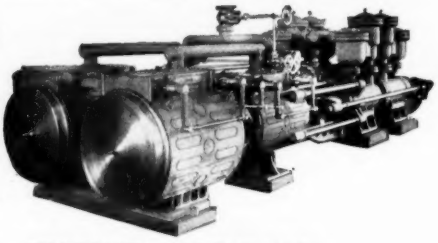

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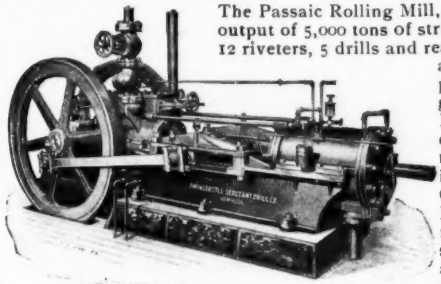

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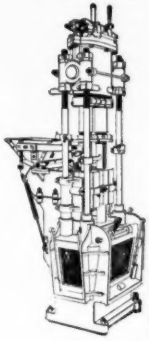

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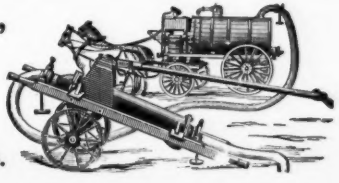

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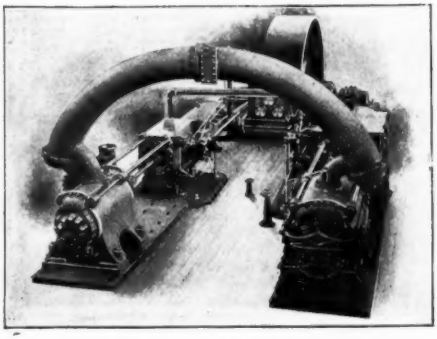

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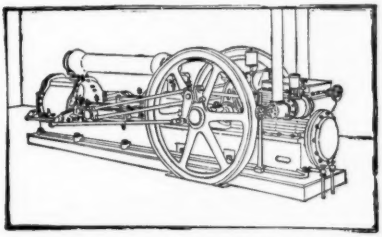

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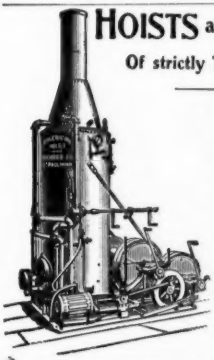

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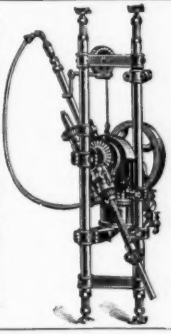

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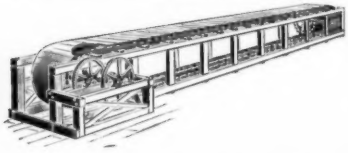

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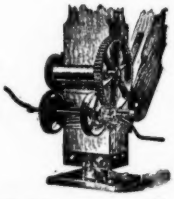

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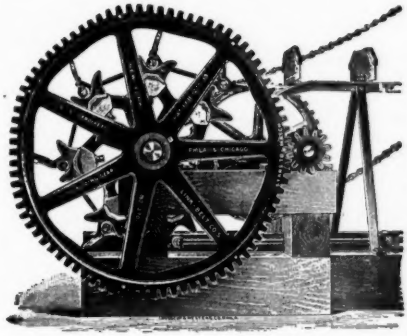

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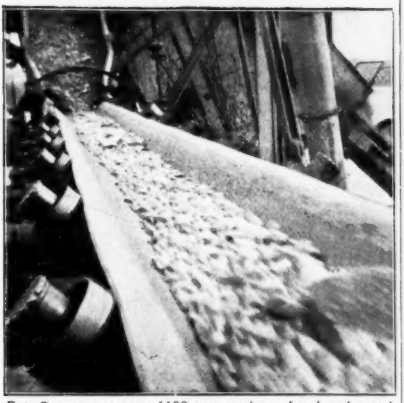

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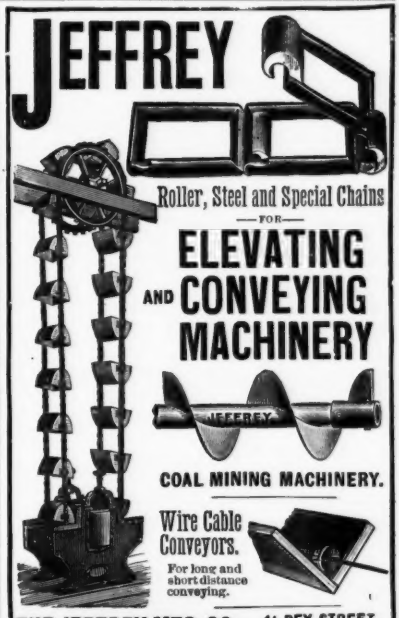

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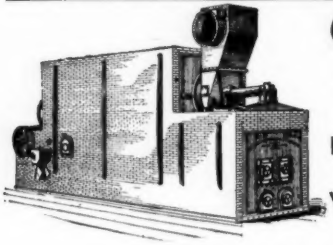

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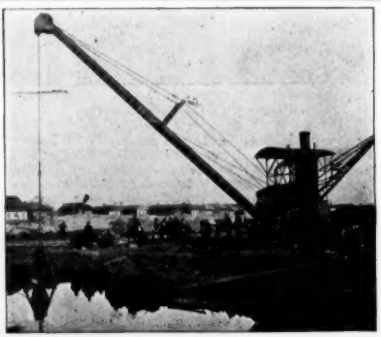

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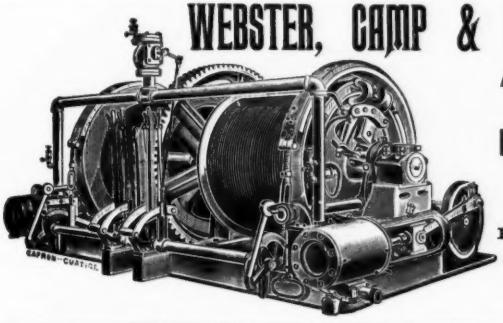

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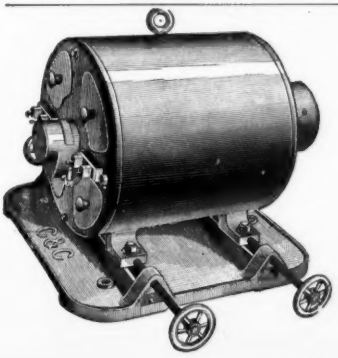

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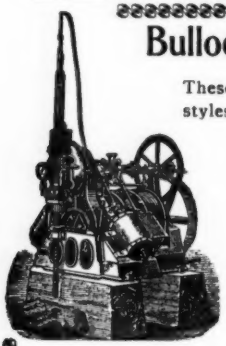

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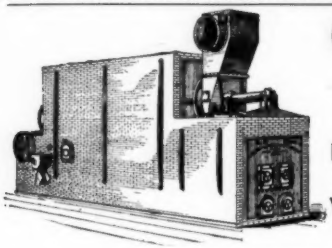

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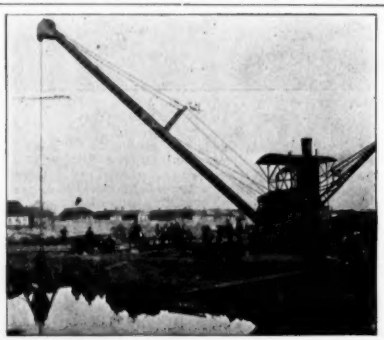

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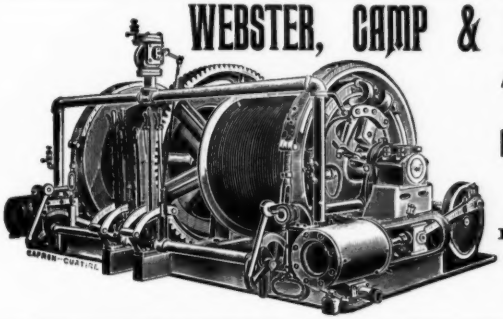

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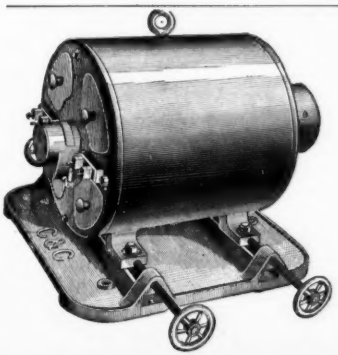

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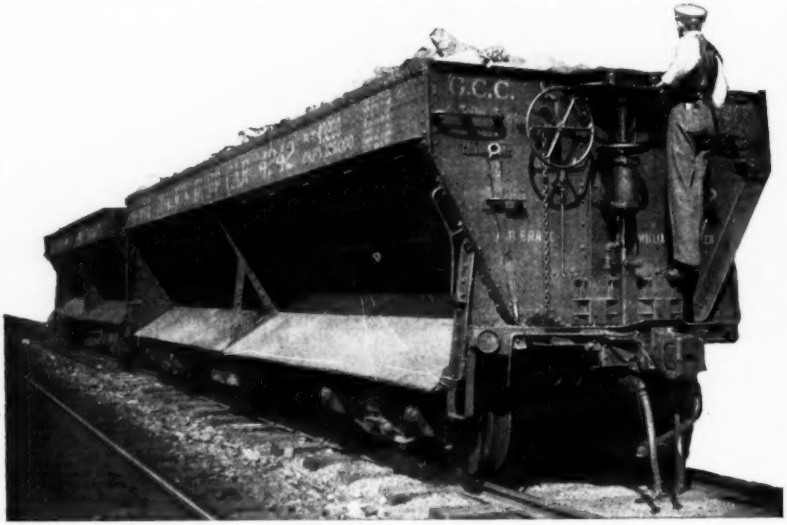

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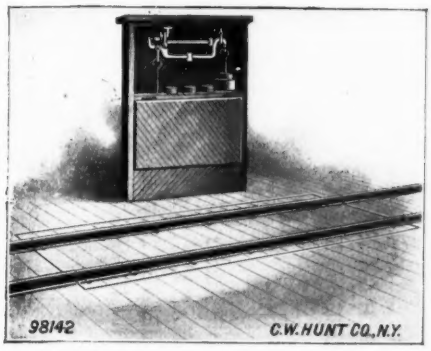

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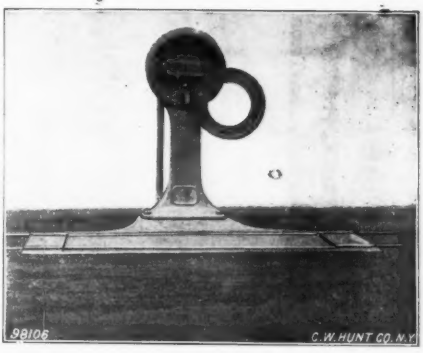

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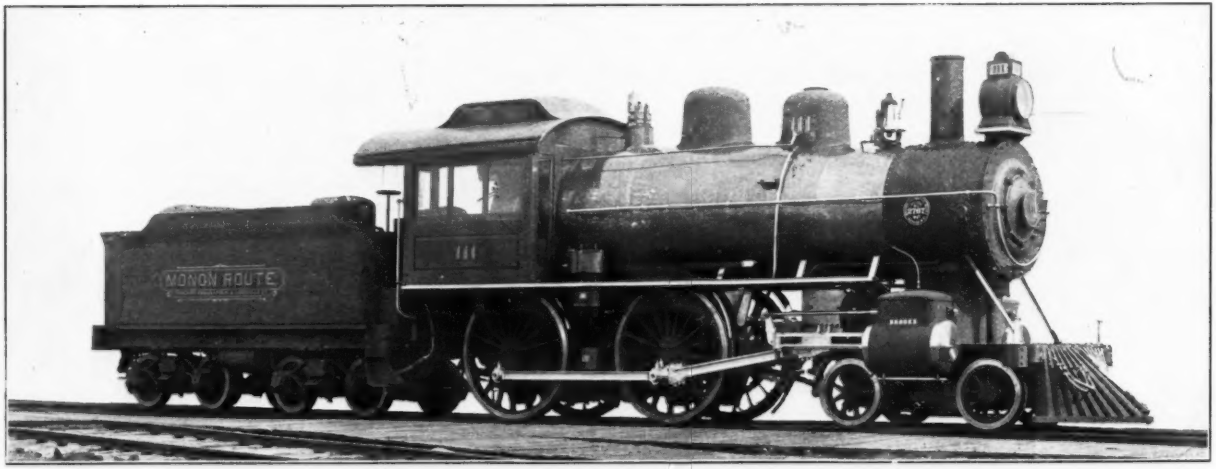

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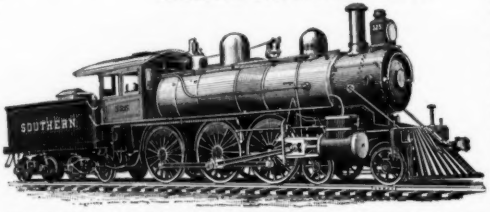

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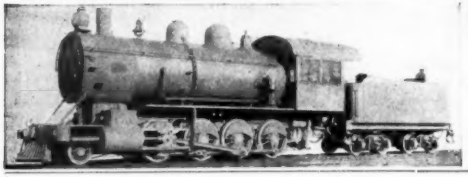

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See page 1029 for current index.

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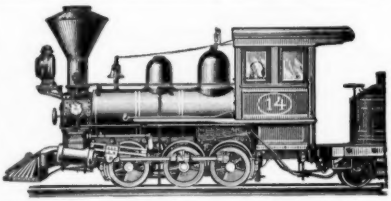

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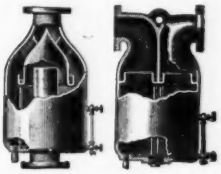

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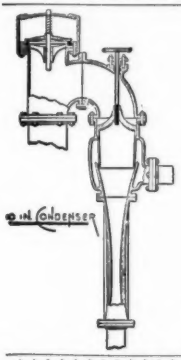

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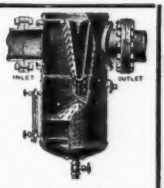

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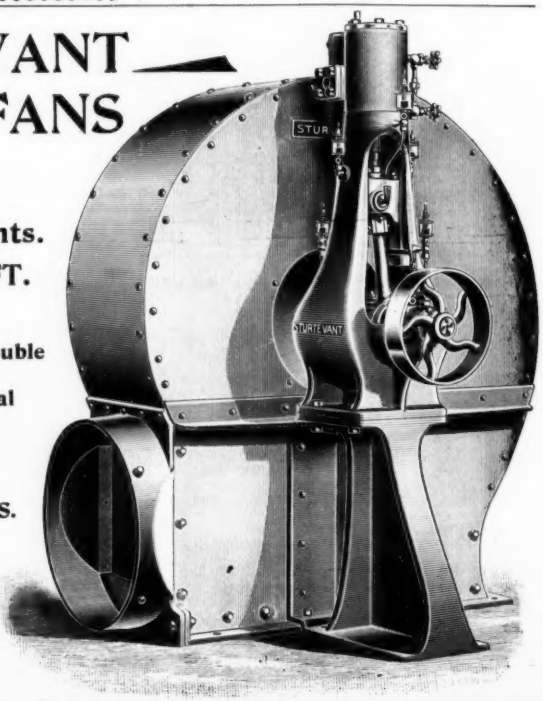

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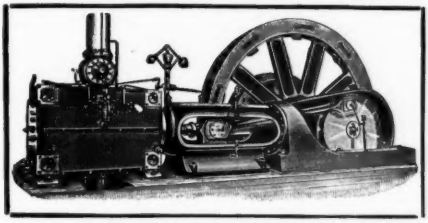

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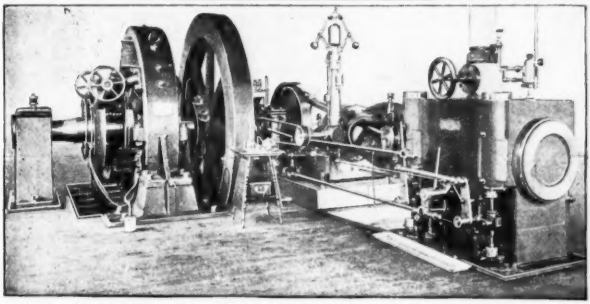

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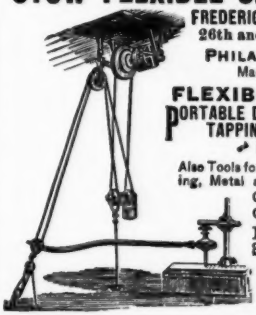

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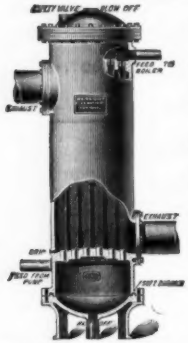

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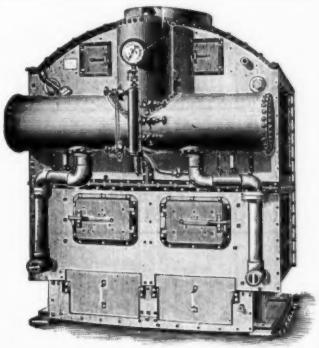

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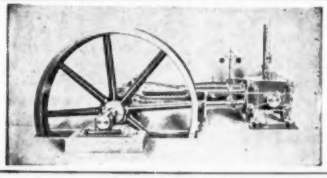

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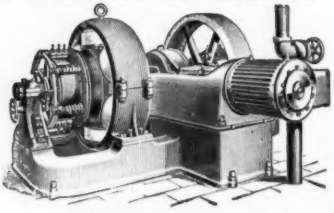

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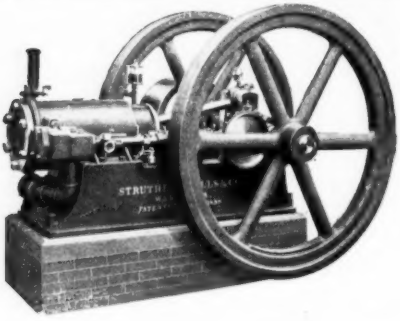

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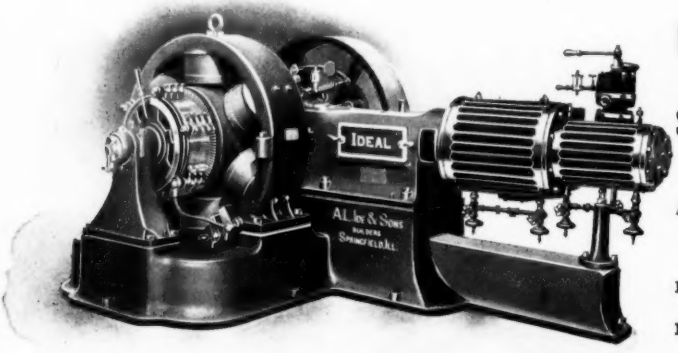

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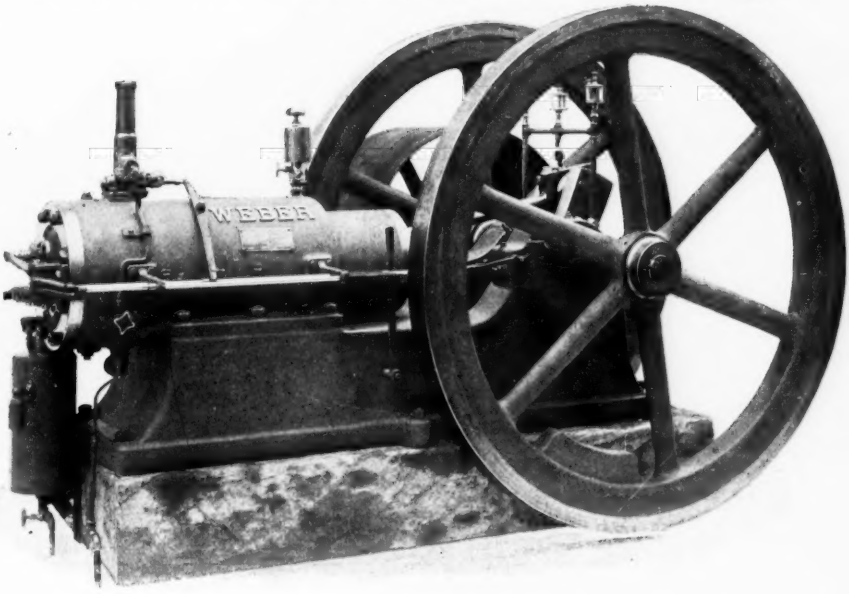

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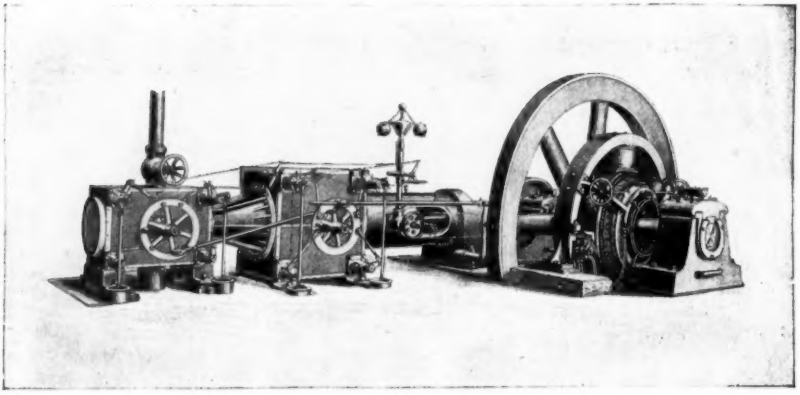

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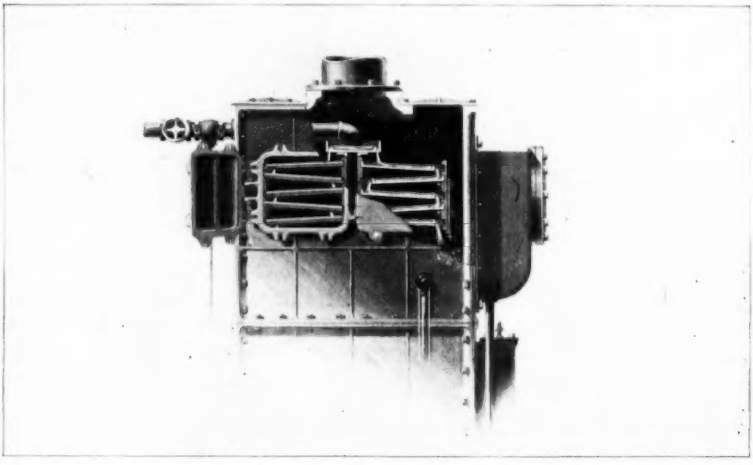

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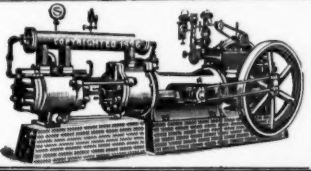

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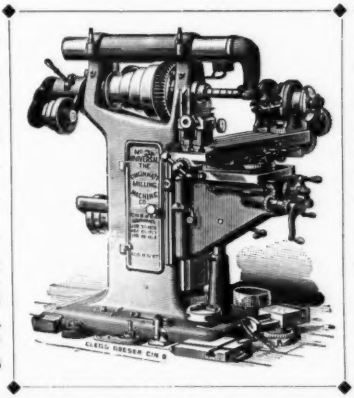

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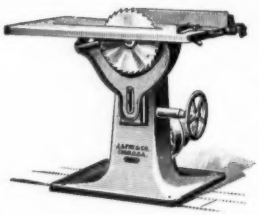

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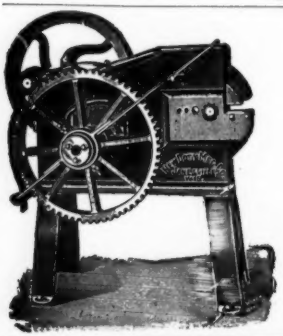

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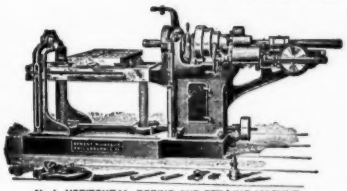

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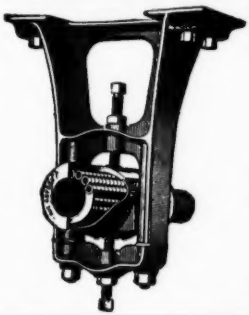

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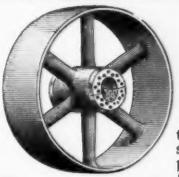

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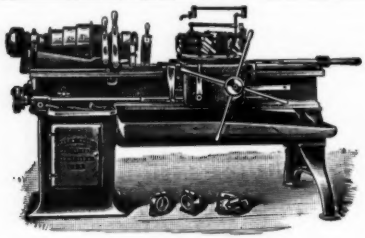

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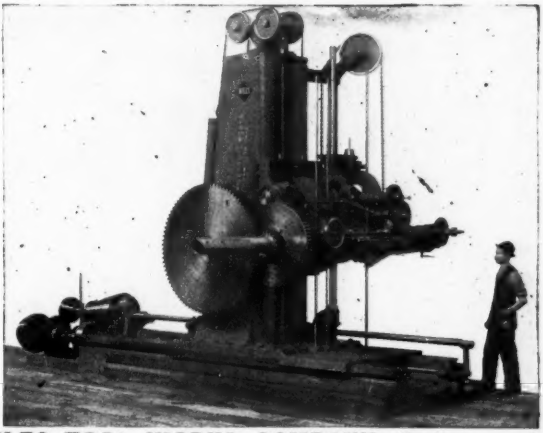

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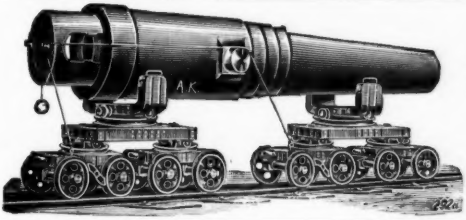

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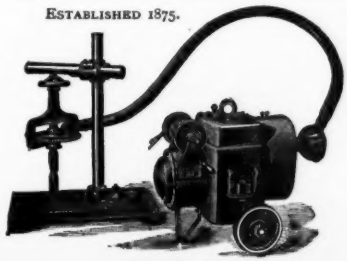

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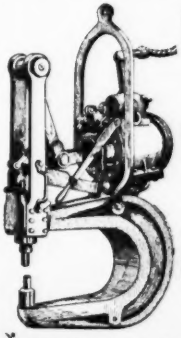

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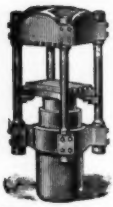
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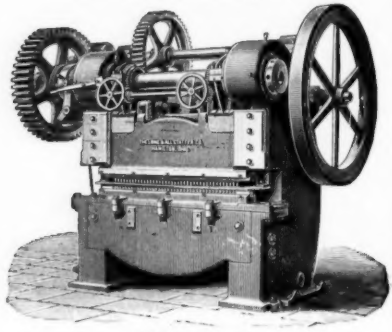
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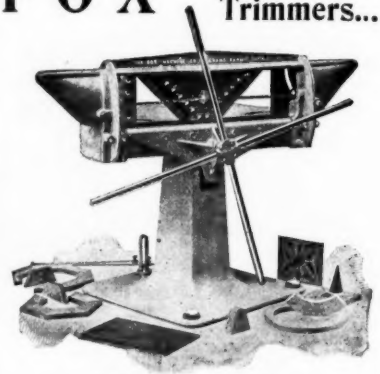
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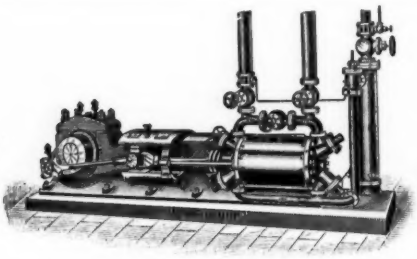

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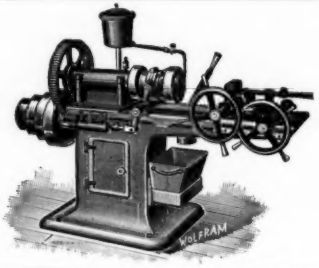

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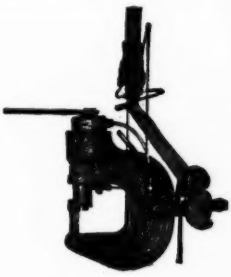

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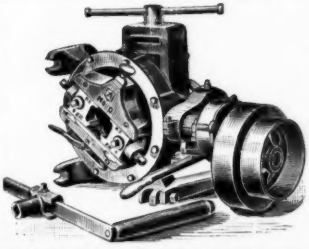

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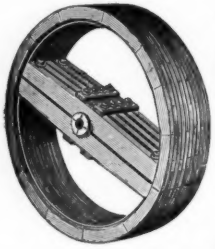

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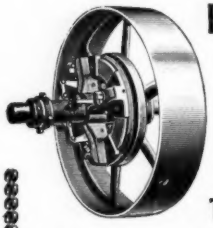

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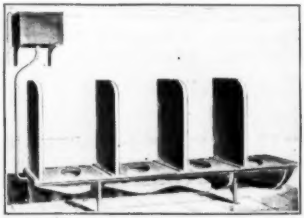

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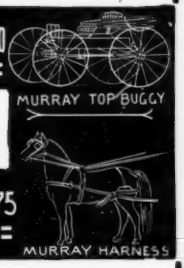

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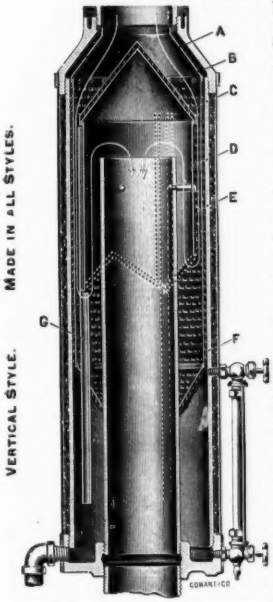

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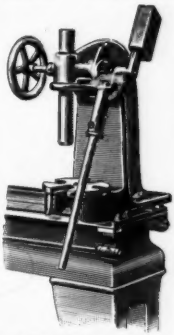

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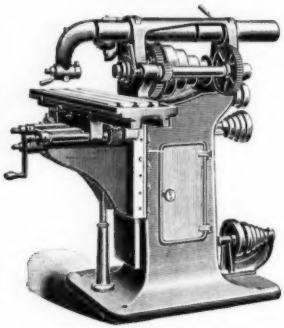

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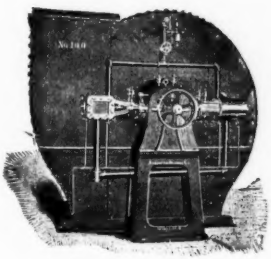

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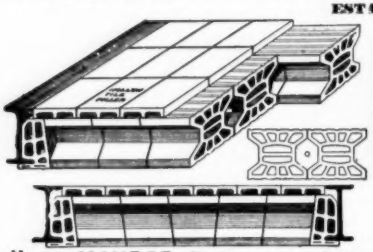

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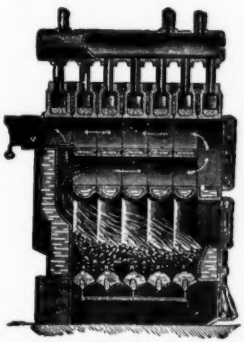

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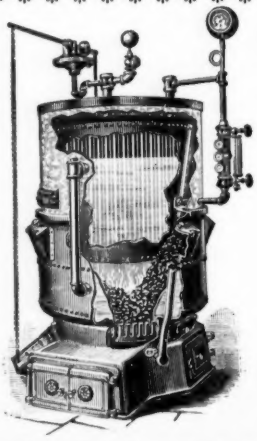

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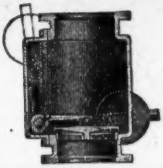

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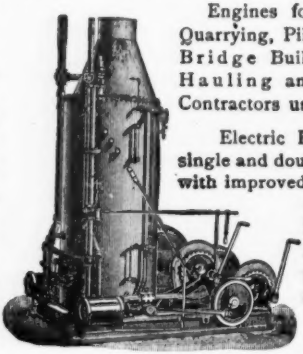

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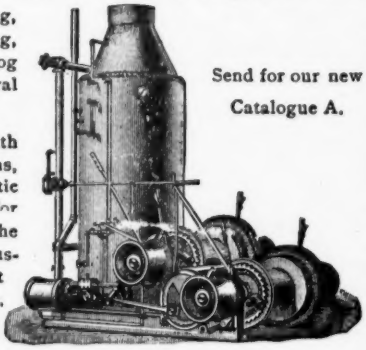

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